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ABSTRACT

These 40 papers were selected on the basis of their contribution to building an effective knowledge base for professionals facing the Pacific telecommunications challenge. A foreword, a list of conference organizations and sponsors, and 13 session summaries precede the papers, which are organized generally by topic: (1) local and national development needs: infrastructures, satellites, and terrestrial facilities (business applications, user needs for telecommunications and communication infrastructure, including political and social and economic aspects); (2) Pacific regional and international infrastructure, satellite and surface systems (business requirements, user needs in the Pacific, institutional infrastructures and constraints in the Pacific, and Pacific satellite/terrestrial systems); (3) international systems and problems (geostationary arc, transborder data flow, information technology transfer and evolution of telecommunications policy in industrialized, Pacific-basin countries, international telecommunications standards, and the Johoka Shakai/information society). Most papers include abstracts and references. (LMM)

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PTC '83

PACIFIC TELECOMMUNICATIONS CONFERENCE

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held January 16-19, 1983
at the
Sheraton-Waikiki Hotel, Honolulu, Hawaii

Edited by
DAN J. WEDEMEYER

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1983

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FOREWORD

PTC '83 is proud to be the first telecommunication conference of "World Communications Year." We recognize the importance of the year and have incorporated its spirit into the conference program. It is in this spirit that the conference organizers, contributors and attendees come together to share the latest thinking, announcements and problems concerning telecommunication in the Pacific Hemisphere.

Telecommunication is an expansive arena. It includes a wide range of systems and services which require special knowledge, training and sensitivities. The policies and plans which guide the development of telecommunications in this Pacific hemisphere are complex and influenced by many cultural, political, economic and technical constraints. It is within this extensive arena that the Pacific Telecommunications Council and PTC '83 finds themselves.

This year's papers have been screened and selected on the basis of how much they can contribute to building an effective knowledge base for professionals facing the "Pacific telecommunication challenge." The quality control placed on the content of session ensures conference attendees a rewarding experience. As the conference days pass you will find a rich environment of professionals, state-of-the-art information and telecommunication exhibits.

This year's proceedings are organized along the lines of the conference. Each day's presentations, from keynotes to roundtable discussions, are arranged in chronological order in this volume. In addition, this year's proceedings contain a separate "session summary" section which presents a condensed review of each individual conference session. It is intended that this will allow each participant to tailor his/her individual needs and interests to conference offerings.

On the final day of PTC '83 a special roundtable is planned. This activity brings together key stakeholders in the areas of Pacific satellite and cable development. In order to make the proceedings as interactive and useful as possible, we have provided note-taking pages for the final roundtable as well as all keynote addresses and panel discussions.

PTC '83 has again assembled an array of professionals which represent academe, business, government and users from a host of international locations. While each participant's approach or interests may vary widely, there is, we believe, a common thread. At the center of PTC '83 and its participants is a spirit of telecommunications development in the Hemisphere which will ultimately translate into higher qualities of life for all Pacific people.

This year's conference represents a good deal of planning on the part of many people. These proceedings reflect much of the official conference content. However, the conference is offered in the hope that participants will go beyond the "official" nature of the meeting and get to know each other, find out what each other thinks, build broader professional networks, and explore. I hope that you will find PTC '83 the best yet and that it will be a useful and rewarding experience.

Aloha,

Dan J. Wedemeyer
Editor, PTC '83

PTC '83 Conference Organization and Sponsors

PTC '83 is organized by the Pacific Telecommunications Council

PTC '83 Conference Organizers

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Monday, January 17, 1983

BUSINESS APPLICATIONS/USER NEEDS FOR TELECOMMUNICATIONS

Chair: Majid Teheranian

- Papers: M. Balderston, "Technology, Policy, Needs and Dollars: Conflicting Pressures in Rural and Remote Telecommunications."
P. Crowder, P. K. Crowder and J. Gerard, "Community Services via Satellite: The Canadian Experience."
M. Dua, "Television Programming in the Service of Deprived in Developing Countries--with Special Reference to India."

This session focuses on user needs for telecommunications with particular reference to remote and rural areas. The technical difficulties in serving the needs of rural populations, the need for socially relevant programming, and the potential use of satellites to service these areas are some of the issues addressed in this session.

Balderston in his article entitled: "Technology, Policy, Needs and Dollars: Conflicting Pressures in Rural and Remote Telecommunications" considers problems which face the provision and maintenance of telecommunications services and facilities in general but which come into special focus with regard to rural and remote areas. Pressures relating to telecommunications such as the stress by governments for urban rather than rural services, technological changes, and tariff policies are discussed, noting the implications to rural and remote areas. Problems of introducing advanced technology into developing countries such as economic constraints and paucity of trained personnel are also highlighted. The author concludes optimistically noting that technical developments aimed specifically at remote and rural telecommunications are increasing in number.

The paper by Crowder *et al.* "Community Services via Satellite--The Canadian Experience" details experience gained in the application of satellite technology for broadcast communications in Canada particularly in the rural and northern areas. The Canadian experience, chiefly motivated by community initiative, has resulted over time in a cost-effective nationwide delivery system for broadcast services. The authors suggest that this experience can be applied in developing countries where similar broadcast needs exist.

Dua's "Television Programming in the Service of the Deprived in Developing Countries--with Special Reference to India" emphasized that within India, television is a medium for the elite. The author suggests that this medium can be utilized to facilitate social change and provides details of two television programs created by social scientists which served to highlight societal problems and injustices. Dua discusses the ramifications of airing such programs in India and calls for the Government of India to provide guidelines for program presentation which will ensure that television becomes more relevant for the poor.

Mimi Nichter
Rapporteur

COMMUNICATIONS INFRASTRUCTURES: SOCIAL/POLITICAL/ECONOMIC ASPECTS

Chair: S. Rahim

- Papers: H. Dordick and P. Lum, "New Telecommunications Policy in the U. S.: Who Benefits? Who Doesn't?"
Y. Ito, "Recent Trends in the Japanese Telecommunications Policies."
I. Singh and L. Conroy, "The Telematic Society: Implications for the Pacific Region."

In this session, past and present telecommunications policy concerning governments located in the Pacific region are examined. The region is of no small concern, according to Singh and Conroy, because it includes more than 50 countries, territories and independent possessions representing almost half of the world's population.

Singh and Conroy also express concern for a widening "information gap" among the nations of the Pacific region due to an unfair distribution of communication resources. In the past, industrialized nations monopolized the available radio frequencies. Now it appears that they will seize the opportunity to garner more than their fair share of the geostationary satellite orbit. To compete in the field of information technology, developing nations must be permitted equal access to these communication resources. Thus, the right to communicate may also be interpreted as a "right to orbit."

Ito cites policy concerns based on historical trends in Japanese telecommunications policy. Defining telecommunications policy as "administrative, judicial, and legislative measures taken to achieve social goals through electronic media," Ito describes a history of telecommunications policy in Japan and identifies four basic postulates to explain some of the recent trends. He discusses the commonalities and divergences between telecommunication policy shifts in Japan and those occurring in other industrialized countries, especially the United States. He agrees with a Japanese policy maker that "We are now at an exciting time."

Dordick and Lum describe the current attempt to deregulate the telephone industry in the United States by shifting the regulatory responsibility from the federal government to the individual states and to place more reliance on the market place to resolve issues that arise. The effects of these and other changes in telecommunications policy, will result in higher local telephone rates and more variation in the quality of service from among the different operating companies. These actions will likely be followed by similar moves in the cable television and broadcast arenas. It is likely that with deregulation the various companies will begin to compete with each other. Telephone companies and cable television systems will offer similar services. Of the alternatives being considered for increasing or decreasing regulation, Dordick and Lum claim that the most certain prediction is that the discussion of communications policy will be on the nation's agenda.

Lee Cahn
Rapporteur

SATELLITE AND TERRESTRIAL SYSTEMS

Chair: K. Nosaka

Papers: T. Mori, "History and Current Status of Communications Satellite in Japan."
E. Piekaar, "Fighting 'Isolation Fever': An Inexpensive Voice-data Satellite Service for Remote Locations."
R. Spratt and W. Southwood, "Vanuatu: Telecommunications."
S. Ueda, "Fiber Optics in Japan."
G. Westwater, "Meteor Burst Communications Systems."

The use and growth of telecommunications hardware and systems in both urban and rural areas are addressed in this session. The papers presented deal with the history and development of telecommunications technologies, facilities, and services, ranging from more common terrestrial hardware configurations to state-of-the-art satellite, meteor burst and fiber optic technologies. The diverse user needs and state of "development" within the Pacific Basin are illustrated by the papers in this session, where the utilization and development of telecommunication technologies can be seen within the contexts of "emerging" and "developing" nations, as well as in urban/industrial and remote locations.

Mori presents the history and development of Japanese satellite technology and delivery systems for domestic telecommunications, direct broadcasting, and mobile navigation. While the Japanese actively contribute to international space development and exploration, they are also committed to a high priority for research and development of domestic satellite and space delivery programs. Current plans to implement a second generation of telecommunications satellites are geared primarily to serve isolated areas, public agencies, and as emergency communication links, as well as to provide technical knowledge and experience. Direct broadcast and navigation satellites are also planned for launching within the next five years. A third generation of communications and direct broadcast satellites are scheduled to be in place by the end of the decade to further expand the respective services and research into the design and manufacture of satellite systems.

Piekaar presents a solution to communicating voice and data transmissions to remote locations, such as mining and other isolated resource extraction sites (or communities). This paper presents the 1982 field evaluation of the Single Channel Per Carrier Earth Station (SCPC) system using part of an experimental 14/12 GHz RF channel on Canada's Anik B communications satellite. This satellite thin-route system provides links from isolated spots in British Columbia to the switched telephone network in Vancouver, B.C., Canada. The end user requirements resulted in the following components: a central control station, which provides built-in billing and monitoring facilities and a remote terminal, whose three assemblies are durable, compact, and easily transportable by pickup truck. The author indicates that the system's field test was extremely successful in providing low-cost remote terminals, high-quality, reliable voice and data service, with full integration into global voice and data networks. B. C. Telephone, AEL Microtel, Microtel Pacific Research, and Telesat Canada are involved now developing and refining the system for permanent operation as early as mid-1983, utilizing the Anik C-3 which was launched by the space shuttle in November 1982.

Spratt and Southwood discuss the expansion of the telephone network of Vanuatu (formerly New Hebrides) based on a terrestrial system of low capacity, high quality microwave circuits. Their paper traces the planning, organization, and implementation of this system which links the two major urban centers, and also nine other more rural islands of the archipelago via spine and spur routes. They detail some of the difficulties of site selection, facilities access, and system performance all of which were satisfactorily resolved. The authors also present available information on the rural population's acceptance of the new service which they suggest is overwhelmingly positive.

Ueda's paper covers the history and current state-of-the-art developments and research into fiber optics hardware and applications systems. He details specific developments in optical materials, fibers, and component technologies and describes the future technologies applications, and markets of fiber optics systems. Ueda notes the rapid development of fiber optics technologies and practical applications of these technologies in Japan's public communications, electric power and traffic controls, industrial communications and control, TV and CATV operations, and computer links. This paper emphasizes the potential of future optical technologies and trends for resource-poor, densely populated, and advanced information societies such as Japan.

Finally, Westwater in his paper "Meteor Burst Communications Systems" details a relatively new system of telecommunications which utilizes the ionized trails of meteors which enter the Earth's atmosphere. By transmitting a continuous, coded signal, messages can be reflected off of the trail. This application, Westwater says, is currently being used to transmit data from remote sites to a data collection center and may be useful in Pacific Island communication applications.

Chris Jones
Rapporteur

Tuesday, January 18, 1983

BUSINESS REQUIREMENTS/USER NEEDS IN THE PACIFIC

Chair: George Lissandrello

Papers: P. French, "International Telecommunication Services for the Business User."
J. Hurd, "Satellite Communication for the Pacific Islands: An Alternative to Isolation."

The papers presented in this session focus on two main areas: the telecommunication needs of Pacific Basin nations, and business users. Recent Pacific telecommunications studies and surveys undertaken by several international and regional organizations are described and the results are discussed. Telecommunications regulatory and international information flow issues that affect business users are also presented in this session. A call for consultation between user groups regarding national regulatory policies for telecommunication services is advised and business users affected by those policies are urged to participate in a forum addressing those issues.

Hurd reviews recent studies on telecommunication options for the Pacific Islands including those undertaken by the U.S.'s National Aeronautics and Space Administration and National Telecommunications Information Administration; the South Pacific Bureau for Economic Development, and INTELSAT. In addition, interest expressed by Japanese Research Institute of Telecommunications and Economics, Australia, Indonesia, and possibly the Soviet Union, broaden the number of interested parties.

Many of the alternatives are beset by a number of technological, economic, and political difficulties. In light of this, however, the most interesting yet controversial option appears to be the use of the western-most satellite of SPACECOM's Tracking and Data Relay Satellite System (TDRSS). While this option was termed as being "impractical" by NASA, the long-range political and economic benefits for the United States must certainly be taken into account.

T. Patrick French's "International Telecommunication Services for the Business User" addresses regulatory and trade issues confronting business users. French notes that a certain level of regulatory supervision is necessary in order to control the unquestioned expansion of monopoly practices. The Business user's "right to interface" must be assured through the freedom to attach suitable equipment to national and international networks, provided that well defined national interests are not threatened, and the integrity of the networks is not at stake.

In addition, it is important to maintain the "Freest possible environment for the transfer of information across national boundaries." Information must be viewed as a commodity, and barriers to the free-flow of information as legitimate trade issues.

In light of these two business user needs, the Pacific Telecommunications Council must take the initiative and develop itself as a forum for discussing regulatory and trade issues by assembling all affected parties, and increasing the participation of business users.

Wayne Yasatomi
Rapporteur

INSTITUTIONAL INFRASTRUCTURES AND CONSTRAINTS IN THE PACIFIC

Chair: R. Melo

Papers: N. D. Karunaratne, "Telematic Infrastructures for the Developing Pacific."
A. L. Levine, "Satellite Communications for Public Service in the Pacific Basin: Policy, Institutional and Infrastructure Issues."

The implementation of improved telecommunications systems is addressed in this session. Seen as highly desirable for Pacific Island nations, new or improved telecommunications systems face a number of institutional, infrastructural and policy constraints. Satellite systems designed to serve the Pacific Basin will require regional coordination and cooperation on an unprecedented level in order to overcome present and potential obstacles toward successful implementation.

Neil Karunaratne urges the development of telematic (telecommunications and computers) infrastructures to promote trade, industrialized and regional cooperation. Citing the global information and telematic revolution, Karunaratne points to the potential use of telematics to diffuse services. Services could potentially be diffused in a shorter period of time than through conventional infrastructural development strategies. Conventional strategies, based on massive capital-intensive inputs, commits large quantities of scarce capital into a limited number of projects. Telematic infrastructures, on the other hand, demonstrate a comparative advantage over a wider range of basic services. While the capital costs of telematics is too burdensome for a single Pacific Island nation, a regional approach could allow the Pacific Island nations the opportunity to plan and implement a satellite system designed for these telecommunication needs.

Arthur Levine agrees that a regional satellite system could provide a means to meet public service and rural needs. Levine points out the advantages of satellite systems when dealing with the large distances involved in the Pacific Basin. He warns, however, of the great number of political, economics and social factors which could alone or in combination stymie a cooperative and coordinated effort for a regional satellite system. The challenge for establishing a regional satellite system is "to find a means of capitalizing on (the present) cooperative impetus" among Pacific Island nations, while "easing the divisions, strains and fears ..." attributed to a technological and cultural invasion through telecommunications. Organizational arrangements for establishing a regional system are seen as crucial, and Levine examines the four options outlined by the Public Service Satellite Consortium (PSSC). Problems associated with the issues and constraints can be solved in identified and dealt with on specific levels.

Patrick Coolen
Rapporteur

PACIFIC SATELLITE/TERRESTRIAL SYSTEMS

Chair: Z. Yokota

Papers: R. Jennings and P. McManamon, "Parametric Approach to Thin-Route Earth Station Requirements."
K. Yoda and Y. Ugai, "System Configurations and Applications in Domestic/Regional Satellite Communications."

Advancing technology is making satellite communications a cost-effective investment. This session addresses the need for less expensive communications systems as a way of meeting the needs of lesser developed countries and of those in remote and widely separated locations. These papers deal with various systems and discuss how they can be used to their full capabilities at a lower cost.

Raymond Jennings and Peter McManamon state the need to reduce costs for thin-route applications (one or two telephone circuits per earth station) of satellite technology. Although such systems are well-suited for connecting remote locations, their use depends on a variety of elements including the availability of leased satellite resources and decisions regarding which networking system (MESH or STAR) will be used. Digital technology is described which reveals probable cost reductions based on thin-route configurations.

In "System Configurations and Applications in Domestic/Regional Satellite Communications", Mr. Yoda and Mr. Ugai address managing engineers who will be responsible for domestic or regional satellite planning. The various system configurations and applications are examined with consideration given to basic satellite parameters which influence which system will be selected. Examples detail design criteria such as capacity optimization and network configuration. Operational, construction, implementation, and maintenance simplicity are described. This paper illustrates the viability of satellite communications where the use of conventional terrestrial interconnection is not feasible.

Lori Mayer
Rapporteur

THE GEOSTATIONARY ARC: WHO WANTS IT?

Chair: Dr. M. Jussawalla

Papers: W. Melody, "Economics of Spectrum Allocation."
J. N. Pelton, "INTELSAT, the Geosynchronous Arc, and Third World Concerns."

Secretary-General of the International Telecommunication Union, Richard E. Butler has stated many times that a true revolution in telecommunications development would be needed to make a substantial impact on the global village of communications. Unless there is a major breakthrough in worldwide communications development, he said, it seems likely that 5 telephones per 100 or less could still be a typical condition for over half of the world's population even well into the 21st Century.

Pelton presents INTELSAT as an excellent mechanism for ensuring not only equitable access to the geosynchronous orbital arc for all countries but also as a potentially revolutionary tool whereby dramatic strides could be made in telecommunications development by third world countries.

Pelton explores the potential of INTELSAT's providing regional satellite services and a wide range of new types of services through a multipurpose space platform in future decades. He explains the special relevance of INTELSAT's services to third world countries in terms of providing cost-effective and reliable services on a financially equitable basis that allows these countries to invest in the INTELSAT space segment.

Melody focuses on the establishment of a balanced and equitable set of sharing rules for the radio spectrum as a crucial first step toward the creation of an international information environment in which "free" flows will be balanced flows. He recommends that the international spectrum negotiations proceed at two levels: the formulation of specific long-term policy objectives; and the development of transition policies and rules that provide the necessary adjustments to reach the long-term objectives, but which encompass necessary accommodations over the transition period.

Elizabeth N. Kunimoto
Rapporteur

TRANSBORDER DATA FLOW

Chair: T. Meyers

Papers: M. Jussawalla and C. Cheah, "The Economics of Transborder Data Flows."
K. Leeson, "Elements of International Communications Policy."

Transborder data flows are an emerging phenomenon in international communications resulting from the combination of computers and telecommunication industries. Ken Leeson's paper presents a discussion of the necessary components of formulating an international communications policy to deal with this phenomena as policy on transborder data flow as part of the broader issue of policy on international communications. Meheroo Jussawalla and Chee-Wah Cheah's paper discusses the limitations that government regulations may impose upon economic gains which transnational corporations can achieve in the business of transborder data flow.

Devising a comprehensive policy on international communications requires the consideration of six issues: a view of the international process underway in communications, scores of individual issues comprising the field, goals and objectives, political commitment, organizational structure in government, and strategies of diplomacy and negotiation. Kenneth W. Leeson's paper, "Elements of International Communications Policy," briefly reviews aspects of international communications policy and their interrelationships. The way information flows internationally and the effects such flows have on the economic and social interest of countries are the collective consequence of policies in areas such as science, trade, and communications equipment.

It is important to obtain insights regarding the policy options and policy preferences that are available to countries, so that decision-makers will be equipped to arrive at investment decisions which will generate future growth in trade and higher economic development. In Meheroo Jussawalla and Chee-Wah Cheah's paper, "The Economics of Transborder Data Flows," the authors examine the economic aspects of information flows both at the international and intercorporate levels with reference to the generation of such flows by transnational corporations. It analyzes the visible changes in the perception of governments regarding the significance of information resources. As dependence for their operations on the international data market grows, transnational corporations are increasingly concerned about the threat of data protection laws. The major impact of regulations on data communications will be to freeze the expansion of corporate information systems. The authors suggest that if transborder data flows are treated as a service they can be valued and exchanged in concrete terms.

Chuck Anderson
Rapporteur

Wednesday, January 19, 1983

INFORMATION TECHNOLOGY TRANSFER

Chair: S. S. King

Papers: H. S. Dordick, "Computerization and the Transformation of Society."
O. H. Ganley, "How Appropriate is Information Technology?"
F. Rosario-Braid and E. J. Fabian, "Information Technology Transfer: The Philippines."

Information transfer can be viewed from theoretical bases as well as from potential and actual standpoints of the process itself. This session focuses on not only the impact of computerization but factors that aid or hinder its realization.

Dordick's "Computerization and the Transformation of Society" reviews some basic aspects of new technology. He presents a major debate that questions whether computerization is merely another step in the process of technological change or whether it possesses a transforming impact that is greater than the Industrial Revolution. Dordick, while not resolving the debate, presents three areas of inquiry to determine if a transformation is occurring. These inquiry areas include the availability and nature of work; the privatization of information; and the need to redefine work, employment, and unemployment.

Ganley's paper "How Appropriate is Information Technology?" discusses the U. S. Government's growing recognition of development problems. He notes several issues that need to be considered when developing and implementing a new technology. These include: the suitability and adaptation of a technology, cultural and social change, and the question of who pays for new technologies. While acknowledging the potential for modern communication and information technologies, he also urges a cooperative effort to develop coherent national policies for their use.

Rosario-Braid and Fabian look at a wide range of potentials and limitations in their paper "The Information Technology Transfer: The Philippines." The present pattern is described as linear, centralized and diffusionist although recognition of the need for popular, interactive models do exist. Traditional, cultural and sociological events have limited the impact of information transfer to date. After reviewing these points, the authors suggest utilizing the Domestic Satellite Philippines, Inc. (DOMSAT) to develop a prescriptive communications model that will provide easier access for the people thus resulting in greater use and participation.

John Southworth
Rapporteur

EVOLUTION OF TELECOMMUNICATIONS POLICY IN INDUSTRIALIZED PACIFIC-BASIN COUNTRIES

Chair: D. C. Robinson

Papers: T. Keulemans, "Australian Communications Policy."
T. L. McPhail, "Canada's DBS Woes: Culture or Profit?"
D. C. Robinson, "A Critical Approach to U. S. Communication Policy."
G. A. Wagner, "The Evolution of Telecommunications Policymaking Structures and Processes in New Zealand during the Period 1960-78."

This session examines the effect of new telecommunications technologies on information-based societies. The papers in this session indicate that careful long-range planning is needed to address

the economic, social and political issues affected by the introduction of these new technologies.

Robinson's "A Critical Approach to U. S. Communications Policy" focuses on the consequences of current U.S. emphasis on deregulation and market-place competition. She discusses the lack of government planning for the development and implementation of new technologies and for their integration into existing systems which are protected by vested interests and regulatory precedents. She states that this lack of planning will obliterate beneficial social principles established over the past century by older communications technologies. The victims of this change will include universal service, fair price, diversity, localism and system integration.

McPhail's "Canada's DBS Woes: Culture or Profit" examines conflicts generated by tilting the Canadian-developed (and subsidized) direct-to-home broadcast satellite system, Anik-C, to serve U.S. customers rather than the Canadian North. He further explores implications of open-sky satellite sharing policies, TV signal spillover across national boundaries, progress towards a continental information pact, and concern by a software recipient nation about becoming "an information colony in the 21st century."

In "The Evolution of Telecommunications Policymaking Structures and Processes in New Zealand during the Period 1960-78," Wagner discusses the need for and movement towards long-term planning for New Zealand, an importer of telecommunications technologies. Two case studies, the establishment of toll-free telephone services, and the establishment of a satellite earth station provide insights into New Zealand's telecommunications policymaking processes and organizational structures.

Keuleman's "Australian Telecommunications Policy" advocates long-term planning and development of a comprehensive communications policy rather than continuation of a "band-aid" approach to specific developments or problems. He discusses implications of potential increased satellite communications capacity new possibilities for interconnecting and networking, and recommendations advocating private sector network competition.

Barbara Klemm
Rapporteur

INTERNATIONAL TELECOMMUNICATIONS STANDARDS

Chair: E. Lohse

Papers: I. G. Dewis, "Formulating a Communications Strategy."
E. Lohse, "Trends in International Standardization."
B. J. Murdock, "Network Digital Standards."
T. Shikama, Y. Ujihashi, C. Matsuda, and H. Takahashi, "The Layer Model and Error Control for Satellite Communications."

The papers in this session have two points in common: a) they are all highly technical in nature, and b) they all address, from a variety of perspectives, the issue of telecommunications standards in a world moving from analog to digital systems.

Edward Lohse's paper, "Trends in International Standardization" argues that new international telecommunications standards are needed for a variety of reasons: the development of new technologies; the increasing complexity and globalization of present systems; and a new emerging legal, political and economic environment. He also discusses some existing salient problems which include the lack of coordination between national and international standard writing as well as the competition between several standardization bodies. In order to cope with these new trends and salient problems, Lohse calls for "automation, reorganization, preference of international standards over national standards and broader base participation."

B. J. Murdock's paper, "Network Digital Standards," is concerned with the interoperability (i.e. the ability to easily interconnect different systems) of various digital transmission hierarchies. Effective interoperability, argues Murdock, depends largely on the acceptance and coexistence of reasonably compatible digital and analog hierarchy standards and interfaces. Although analog and digital networks must presently coexist, in the future, digital will be predominant. Murdock argues that the standard presently under consideration for implementation in the Philippines is worthy of serious consideration by policymakers and planners from other areas as well.

Authors T. Shikama, Y. Ujihashi, C. Matsuda, and H. Takahashi in their paper, "The Layer Model and Error Control for Satellite Communications," are concerned with the location of the layer function for satellite computer networks in which the packet multiple-access scheme is employed. The relation between the layer model and the error control is discussed in accordance with the ISO (International Organization for Standardization) Reference Model. The authors conclude, after the analysis of a simulation model, that connectionless-data-transmission is effective for satellite communications, and that a

satellite computer network can be constructed that is effective and efficient.

Ian G. Dewis' paper, "Formulating a Communications Strategy," presents the communication information strategy of B. L. Systems Limited. This strategy covers all types of information that need to be transmitted between B. L. Systems Limited and its customers' sites. The strategy assumes that analog transmission will be replaced sometime in the 1990's by digital transmission and communications. The B. L. Systems Limited strategy also "addresses the issue of communications standards by adopting the use of ISO, 'Open Systems Interconnection', recommendations as appropriate ones become available."

Sohail Inayatullah
Rapporteur

JOHOKA SHAKAI/INFORMATION SOCIETY

Chair: L. S. Harms

Papers: M. Kawasaki, "Videotex Services in Japan: CAPTAIN System."
G. Van Valkenburg, "QUICKSCAN Electronic Publishing—A Practical Broadband Information System."
J. Voge, "From the Information Society to the Communication Society."

The words *Johoka Shakai* or Information Society have been used to describe an emerging social order which is based on the synthesis of computer and communication technologies. In this session, two papers describe such technologies and a third examines their possible impact on society.

Based on the evaluation of the first stage trial of the CAPTAIN system in Japan, a second stage trial was launched in August 1981 with commercial service scheduled to be implemented by the end of fiscal 1983. In his paper, "Videotex Service in Japan: CAPTAIN System," Kawasaki outlines this system emphasizing the present status of the second stage trial. He notes that the second stage trial is distinguished both by the introduction of new services, such as a closed user group service and an order entry service, and by the enhancement of existing services. He then presents survey results which show both user satisfaction with some services and a desire for new and improved services. Kawasaki concludes by discussing the future of the CAPTAIN system in terms of development of user terminals, enhancement of information and enlargement of application fields, and offering services at an inexpensive price.

In this paper, "QUICKSCAN Electronic Publishing—A Practical Broadband Information System," Van Valkenburg introduces "possibly the first practical system of delivering high volume text and image via broadband networks for local search and readout." He points out that QUICKSCAN requires no new technical standards and no hardware modifications at the user's end. Rather, it makes use of the widely-available global television infrastructure by transmitting graphics and text to videocassette recorders for later readout. Van Valkenburg outlines several advantages over narrowband systems. He notes that since the bandwidth shortage is over for most of the world, such systems as "teletext and videotex, which are designed to squeeze the last ounce of use out of narrowband networks, ... are in for a reduced share of the perceived market."

The basic theme of "From the Information Society to the Communication Society" is that "economic growth has lead to an information society in crisis." By comparing the economy of communications and the economy of complex system's interactions, Voge demonstrates the urgent need for a more equitable distribution of the organizational structures of human society. According to Voge, "the only hope for overcoming this crisis lies in the emergence of a new society which, fostered by socioeconomic pressures with the aid of computer and communication technologies, will be a decentralized communication society, made up of semi-autonomous, convivial, yet independent micro-societies."

Mitch Stocks
Rapporteur

TECHNOLOGY, POLICY, NEEDS AND DOLLARS :
CONFLICTING PRESSURES IN RURAL AND REMOTE TELECOMMUNICATIONS

Michael Balderston
Telecom Australia

AUTHOR'S NOTE

The views expressed in this paper are my own and not necessarily those of Telecom Australia.

ABSTRACT

The provision and maintenance of telecommunications services and facilities must face problems in any situation. However, rural and remote areas have some special characteristics which tend to bring such problems into sharper focus. In this paper I discuss these characteristics and the problems which can come about when they make conflicting demands on the planning and provision of telecommunications in non-urban areas.

CHARACTERISTICS OF RURAL AND REMOTE AREAS

Compared with urban areas, rural and remote areas differ in several ways significant for telecommunications.

1. The basic and most obvious difference is that average customer density is lower and therefore the average distance between customers is greater. In Canada a population density of 400 people per km² is taken to be the boundary between "urban" and "rural", and 0.4 people per km² as the boundary between "rural" and "remote" (1). In Australia, qualitative definitions for rural and remote customers are used. For example, "remote" subscribers are considered to be those more than a single line-of-sight radio hop from an existing trunk transmission or other telephone facility; this usually means further than 40-50 km (2). The ITU also uses a qualitative definition for "rural zone", but in addition characterises it as having an average subscriber density of less than 50 per km² and/or isolated communities of less than 1000 subscribers (3).

2. Per-capita income tends to be lower. This applies in both developed and less-developed countries (4).

3. Because of these factors, it is often more difficult to provide infrastructure including roads, electric power, etc. Thus, such facilities tend to have lower priority in rural and remote than in urban areas, and hence be inferior, provided later, or both.

4. The greater distances and inferior or at least more expensive transportation available results in a greater per-capita need for telecommunications. However, demand is usually suppressed by an inadequate supply and/or unaffordable cost.

5. In spite of the potentially higher per-capita demand, the low subscriber density leads to a lower aggregate demand than in urban areas. This makes it difficult to take advantage of economies of scale in the way urban areas have done. For example, the trade-off between switching and transmission costs leads to smaller exchanger in rural areas. The fixed establishment costs of exchanges then result in higher per-subscriber costs.

6. Economic difficulties are compounded by the fact that less-developed countries tend to have a greater percentage of their population in rural and remote areas, compared with developed countries (4).

TELECOMMUNICATIONS NEEDS

Among Governments and telecommunications authorities there is a tendency to define rural and remote telecommunications needs in terms of what is available, which is to say lower in quantity and quality than urban services. However, aside from differences in emphasis such as the greater requirement for transportation-substitution mentioned above, rural and remote needs are essentially the same as urban needs. They have been discussed at length elsewhere (5, 6) so I will only list them here:

1. Telephone - probably the prime need although not always given the highest priority.

2. Broadcast radio - often made available before telephone services.

3. Television - entertainment TV is at least as popular in rural and remote areas as elsewhere. Educational TV is needed more but is often less available.

4. Telex and data services - frequently overlooked but still important.

5. Conference services - audio can sometimes be included in the telephone service; video is seldom considered.

6. Recorded information, videotex, teletext, facsimile, electronic mail, etc.

Because the telephone is so basic, much of my discussion is directed to that service. Many of the same considerations apply to other services as well and the applicability of the discussion to them should be borne in mind even if they are not mentioned specifically. The special uses of these services for the unique needs of remote areas (distance education, telemedicine, etc) should also be noted.

PRESSURES RELATING TO TELECOMMUNICATIONS

We can identify many specific technological developments which affect telecommunications. The basic pressure, however, is change. New devices and new techniques make possible new features and services, better performance, easier maintenance, lower power requirements, occasionally even reduced costs. Not only is there technological change, but the rate of change is continually increasing. From the viewpoint of telecommunications authorities, this technological change is a mixed blessing. On the one hand it makes it possible to expand and improve existing services and increase efficiency so as to reduce real costs. On the other, it creates a demand for the new and improved services which existing constraints (legal, financial, etc) may make it difficult to provide. Even without these constraints, there is the problem of replacing equipment before the end of its economic life. Continual change also offers the dilemma of whether to provide a service now or to wait for further technological developments which may result in still better features and/or lower cost.

In the case of rural and remote areas in general and less-developed countries in particular, this technological change can be an enemy of "appropriate technology" for two reasons. First, there is again the problem of demand for new features and services as they become possible rather than as they become available, and "appropriate" technology may not be able to supply them. Second, the rate of technological change means that what is appropriate today may not be tomorrow.

The basic pressure in the policy area is that, since access to telecommunications has come to be widely regarded as a right rather than a privilege, nearly every Government and telecommunications authority has universal availability as an ultimate goal. The difficulty comes in establishing the priorities and selecting the means to reach that goal. Especially in developing countries, universal availability must often be postponed because other goals are given higher priority. In developed countries, the urban population tends to be greater than rural and remote. In less-developed countries, if the urban contribution to national product is not actually greater, at least it is usually seen as being more important to development than the rural contribution. Which then should have priority, a universal basic service or enhanced services for urban areas? A frequent result is that telecommunications authorities, whether driven by profit motive or Government directive, stress urban services.

A few conflicts are already obvious when only technology, policy and needs are considered. When dollars are included, it sometimes seems as if there is nothing but conflict. Telecommunications facilities cost money, and they cost more in rural than in urban areas. Neither Governments nor telecommunications authorities ever have enough money to do all the things they might like. At the same time, telecommunication as a whole, long-distance telecommunications, and mass telecommunications have proven to be very profitable. The effects of these economic pressures can be considered in terms of the charges levied for telecommunications services.

TARIFF POLICIES

In the non-competitive situation of telecommunications in most countries, the tariffs charged do not have to be cost-related. In fact, at present tariffs are as often as not dictated more by policies than by economics. However, in several countries there is a trend towards more competition with the goal of better and lower cost telecommunications for the population as a whole, and a consequent movement towards relating tariffs more closely to costs. Unfortunately for rural and remote areas in these countries, this means they can no longer count on what limited cross-subsidisation has been available until now. An example is the possible outcome of the recent settlement of the AT&T antitrust suit in the USA (7).

The three important aspects of a telephone service are initial provision, continuing availability, and the rate of usage. These can be related to the costs of installation, maintenance and operations respectively, with appropriate allocations for common equipment. Cross-subsidisation and other policies can be implemented by departing from the cost formula when setting the charges for each aspect. For example, one might expect that a policy of providing a universally available service while still meeting total costs could be implemented by setting installation and equipment rental charges well below cost, and subsidising them with high usage charges. Some countries in fact do this, but it is more common to relate installation and rental to cost, and instead subsidise rural from urban revenues. It is also common (to different degrees in different countries) to subsidise local usage fees from long-distance revenues.

Another feature of telecommunication policies in some countries is a third alternative to the universal service versus cost-related tariff philosophies. This is the practice, where telecommunication and postal services come under the same Government department, of using telecommunications profits to offset postal losses. It might be argued that the losses are to some degree the result of subsidising rural postal service and to that extent there is some benefit to rural and remote areas in the situation. However, the net benefit, if any, is decreasing as telecommunications substitution for post increases.

Tariff policies have to operate in the context of an apparent large diseconomy in remote and rural areas, while telecommunications in general, and especially long-distance telecommunications, are very profitable. An aspect which perhaps needs more study is the effect of the one on the other: does an increase in rural services lead to a corresponding increase in long-distance usage, with revenues not recognised because they are attributed to the originating caller?

Satellites have introduced a new complication to tariff policy. Long-distance costs and tariffs have traditionally been distance-related. Satellite costs are essentially independent of (terrestrial) distance, so a cost-related tariff policy for satellites would result in a fixed call charge. But what should charges be in a mixed network where calls between the same two points may be switched sometimes through the satellite and at other times by a terrestrial route? Worse, what should charges be where one subscriber is connected to a national network by satellite and another, not too far distant, happens to be connected on the ground?

This suggests a related problem in areas with both satellite and terrestrial subscribers. Presumably the choice of which method to use to connect a subscriber is made on cost grounds. This means that potential subscribers close to the network access point will be connected by land, and those furthest by satellite. However, the terrestrial connection must be extended outwards from the access point, while any or all satellite subscribers can be connected essentially immediately. What is the reaction of subscribers in the middle, waiting for the terrestrial extension of the network to reach them, while subscribers more remote than themselves already have service?

SPECIAL CONSIDERATIONS FOR DEVELOPING COUNTRIES

Less-developed countries have an advantage in planning telecommunications in that the planning is unconstrained by a large existing investment in what may be obsolete equipment and facilities. Of course their many disadvantages often outweigh this, and they cannot always take advantage of the opportunity to leapfrog technologies. There may even be a deliberate choice not to use the latest technology or provide the latest service, for one of several reasons other than cost.

Introduction of advanced technology requires the training of personnel to install, operate and maintain the equipment. Once trained, they may find it attractive to work somewhere else, in a city or another country. On the other hand, one of the attractions might be the very availability of that advanced technology, in the form of a wider range of services. Television in particular may be available in cities only or in another country and not at home. Recognition of this possibility, together with the lower cost of broadcasting equipment compared with a complete telephone network, sometimes leads to the provision of radio before telephone. An analogous situation exists in the satellite field, as the cost of a TV receive-only earth station is only a fraction of the cost of even a single circuit telephone earth station.

Training itself presents special problems in developing countries. Skilled local staff, if available, may have to be fully used for installation, maintenance and operations, leaving training functions for expatriate staff. Local trainees, with an education tailored to local conditions, may need preliminary supplemental education before starting training on unfamiliar equipment.

In both developed and developing countries there is a potential conflict between the technological, economic, and demand pressures for advanced, cheaper and newer service, and the broader policy goals of aiding local employment and protecting local industry. If a certain piece of equipment cannot be manufactured locally, there will be opposition to its introduction unless some offset arrangements can be made. This is usually possible for a developed country, but more difficult for a less-developed country. Another example is in telephone exchange equipment. Automatic equipment is cheaper in the long run, but the operators put out of work by its introduction often have difficulty appreciating this.

A further conflict applying especially to developing countries is between the desire to maintain national sovereignty by keeping ownership and control of telecommunication services in the country, and the need for more capital than is available within the country. In some cases the best that can be done is to share ownership with a foreign organisation. This approach has been used to provide Intelsat Standard B earth stations in several Pacific Island countries. Another approach is to surrender some sovereignty and enter into regional arrangements, pooling resources to take advantage of economies of scale. In either case, the limited availability of capital often results in reducing the priority of rural and remote services still further.

CONCLUSION

Rural and remote areas have many telecommunications problems. A paper as short as this can cover only some of them, and still have no room to discuss solutions. I would like to end on a hopeful note, and point out a few encouraging trends. There seems to be more attention being paid to rural and remote problems, evidenced by an increasing number of studies and reports. There are several technical developments aimed specifically at rural and remote telecommunications, for example the Digital Radio Concentrator System beginning field trials in Australia. The increasing applications of digital techniques, packet switching and satellites are reducing the distance-dependence of telecommunications costs, in turn reducing one of the disadvantages of non-urban areas.

Each different country must address the problems and resolve the conflicts in ways appropriate to its particular situation. Compromises will be necessary, and it is important to be aware of what compromises are being made. If this paper causes any telecommunications planners, in Government, private authority, or manufacturer, to consider more deeply the broader consequences of their decisions, it will have served its purpose.

ACKNOWLEDGEMENTS

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Community Services Via Satellite "The Canadian Experience"

Paul A. Crowder, P. Eng.
Peter K. Crowder, C.E.T.
J. Gerard Edwards, M.B.A., P. Eng.

Crowder Communications Ltd.
Burnaby, British Columbia, Canada

Abstract

Many remote and isolated Canadian communities are receiving broadcast television and radio services via satellite. A review is presented here of the growth and development of these services in Canada. Examples of national and regional networks are identified. The experience presented here can be applied to planning broadcast services in any underserved geographic area.

1. INTRODUCTION

This paper details experience gained in the application of satellite technology for broadcast communications in Canada, particularly in the rural and northern areas. It is firmly believed that this experience can be applied in other countries, particularly in the developing nations, where both the opportunity and the need exist for a cost effective approach to satellite and broadcast communications.

The major components or subsystems of a satellite communications network are identified in a general overview.

The specific applications discussed here relate to the provision of television and radio services in rural and isolated communities using a building block staged approach, and ultimately evolving into a satellite fed network.

The concepts of simplicity, economy, and reliability which have been developed for broadcast radio and television can be equally well applied to telephone and other communication needs.

2. HISTORY/BACKGROUND

Historically, radio and television services were available first in the major urban centers, and later, often years later, in small and remote or isolated communities. Service to these smaller communities was usually of lower technical quality and was totally lacking in local content.

In Canada, both government and private enterprise have ensured that densely populated areas are adequately served with radio and television.

The programming available in these high density areas consists of both locally produced and nationally oriented signals. The national signals are being delivered across the country via land line, terrestrial microwave, and more recently via satellite.

In these urban areas the public receive the programming in their homes via cable systems (referred to as CATV), or via over-the-air systems (referred to as broadcast). Typically, both methods of service are available with broadcast usually available free and CATV, being a more comprehensive service, usually available only to subscribers for a fee. Recently, broadcast scrambling has been employed for subscriber pay applications.

Fringe areas around these larger centers have been served by the overflow of broadcast signals from the larger centers or, where economically feasible, by independent systems fed by signal sources from the larger centers.

Commonly, broadcast service is provided via high power transmitting stations operating in the VHF and UHF frequency bands. These are systems ranging in power from 1,000 watts to one million watts.

In the past decade the smaller communities have resorted to various approaches and technologies in an effort to gain service. Low power (1 to 100 watts) over-the-air broadcast systems have been used typically to distribute signals. Signals were received from distant stations and rebroadcast via translator (transposer) systems. Sometimes supplementary service was obtained by sending prerecorded video tapes between communities. Video cassette recorders were also used to feed low power units in areas where no off-air signals were available to rebroadcast.

Typically, a small community say 100 miles away from a center would receive its signal via one or more mountain top translator systems. The greater the distance and the more translators involved, the more the signals were subject to quality degradation because of system losses.

There was a point where the received signal was no longer useable or acceptable and until recently this meant that communities beyond this point had no service. The option of other signal delivery methods using terrestrial systems was simply not economical for the size of community wanting service.

Satellite transmission has changed the economics of distributing television and radio over large geographic areas. By using the approach developed here, many communities, even those comprising as low as 50 homes, now have systems operating -- ones purchased, operated and maintained by them.

The Canadian experience has provided an important lesson. As mentioned earlier the larger areas were served by high cost terrestrial systems; the rural areas developed their own solutions to service. Finally they were all integrated via a satellite network. This means that in any new application, high cost terrestrial systems can be avoided.

A prime example is the publicly owned Canadian Broadcasting Corporation (CBC) which is presently phasing out its terrestrial distribution systems in favour of more cost-effective satellite distribution for both regional and national programming.

3. MODELS

3.1 NATIONAL

In Canada the publicly owned CBC has a mandate to extend service to all Canadians. This service is distributed in two official languages (English and French) and, where applicable, in native languages.

This being a national service, the main core of any day's radio and television programming originates in the major centers of Montreal and Toronto. Originally it was relayed across Canada using terrestrial systems.

Typically, each link in these terrestrial systems involved high capital costs (several millions of dollars) and involved ongoing monthly rental charges for the use of the facilities. Only major centers were served initially because of these high costs.

As early as 1973, CBC began using satellites as a national distribution medium but because of the then high cost per earth station few were actually constructed.

As mentioned previously the CBC is now implementing a distribution system based primarily on satellite rather than terrestrial distribution.

In 1979, the Government of the Northwest Territories began installing low-cost receive-only earth stations in various hamlets throughout the Canadian Arctic. These earth stations, together with low power broadcast systems, were used to receive and distribute CBC Northern service programming, both

radio and television. As of the fall of 1982 all communities and hamlets with populations of more than 250 now have radio and television service. Additional independent commercial service is now being added in those communities to supplement the programming offered by the CBC.

An off-shoot of the introduction of radio and television to the native peoples has been the establishment of their own radio and television networks to produce and distribute locally originated native programming.

Distribution of this native programming is presently via video cassettes delivered between the communities. By the summer of 1983, they will utilize satellite technology to augment the distribution of their own programming.

It is important to emphasize that adequate coverage in the Arctic would not have been economically feasible without satellite distribution and low power rebroadcasting facilities.

The economic viability of distributing commercial radio and television to rural, remote and isolated areas is also well demonstrated by the initiation last year of an independent free enterprise service to serve an estimated 300,000 population base scattered over northern Canada in an area larger than the land mass of the United States. This service began as four channels of television and eight channels of radio. Already only 12 months after its introduction, the service is being expanded to ten channels of television and additional radio channels. It is not government sponsored and it is operating at a profit.

3.2 REGIONAL

Several regional broadcast services are now operating in Canada. For discussion purposes, the Knowledge Network system funded by the British Columbia provincial government is discussed briefly here.

This is an educational network with programming produced and coordinated at various colleges and universities in British Columbia and distributed by satellite throughout the province from a common uplink.

These satellite signals are received in a community using a receive-only earth station; the programming is then distributed in the community via a low power broadcasting system or on an existing cable (CATV) system.

An interesting feature of this network is that it has been made interactive by the use of two-way audio communication via telephone during actual program transmission. This permits ongoing dialogue between the student at a distant location and the instructor at the originating location.

3.3 LOCAL

In areas with scattered and sparse population there is a need for locally originated programming to maintain cultural identity, community awareness, and inter-community exchange of information.

Provision of basic production equipment within the community itself has allowed many small communities to produce and broadcast local interest programming (news, community events, etc.) and has provided a forum for exchange of programming with other communities.

4. A NATIONAL NETWORK

Figure 1 shows the major system components of a national satellite network. There are three parts to such a system: the uplink, the satellite, and the downlink.

A minimum of one uplink, or transmitting earth station, is required. Typically most major urban centers would have an uplink in a fully developed national network. In addition, there may be a requirement for one or two mobile uplinks.

The satellite is the largest single cost in a national network. Presently it is not necessary to own and operate a satellite since arrangements can often be made to time share an existing satellite. Although there is a shortage of satellites presently covering Pacific Rim countries, this is a situation that will change in the near future. More than thirty new satellites are scheduled for launch in the next three years. Many of these could be oriented to serve the Pacific Rim countries.

The downlink or receiving earth station is the least expensive part of the system, and one is required in each local area where programming is to be received.

Figure 2 identifies the system components at the community level used in the three models previously discussed. The common element in all of the three models is the method of local distribution, i.e., low power rebroadcast.

Notwithstanding the fact that cable distribution (CATV) is more cost effective in urban areas, it is not economically viable for rural or remote community applications.

Once a community has established a local rebroadcasting system, it has the capacity to build on its broadcast services, leading up to its integration into national network.

There is a constraint to any of the Pacific Rim countries implementing a satellite network. This is a time constraint only due to the temporary lack of satellite capacity. In the meantime, however, local

distribution systems (low power rebroadcast) can be put into place now, for eventual integration into a national satellite network.

5. THE CANADIAN EXPERIENCE

The evolution of a nationwide network in Canada began as a cohesive plan set by the Canadian government. However, public demand for alternative/increased programming has resulted in the growth of community systems in numbers far exceeding the government's coverage plans for the national service (CBC). At the onset, these community systems were operating without licences and were distributing unauthorized programming.

It has been the proliferation of independent community systems that has resulted in a distribution network being in place to interface with the free enterprise satellite services.

The Canadian experience when viewed in perspective can be applied to a systematic approach for implementing a national network in other countries where broadcast services are not yet available.

5.1 COMMUNITY APPROACH

The success of the many community systems has been due in most part to the key involvement of the total community itself. The basic formula on which this success is based is shown in Figure 3.

6. SUMMARY

The Canadian experience, although fragmented and driven chiefly by community initiative, has resulted over time in a cost effective nationwide delivery system for broadcast services. Adapting this experience to an organized plan will result in an approach well suited to the implementation/introduction of broadcast services nation-wide in any underserved geographic area. Canadian industry is anxious to assist any nation in implementing its plans.

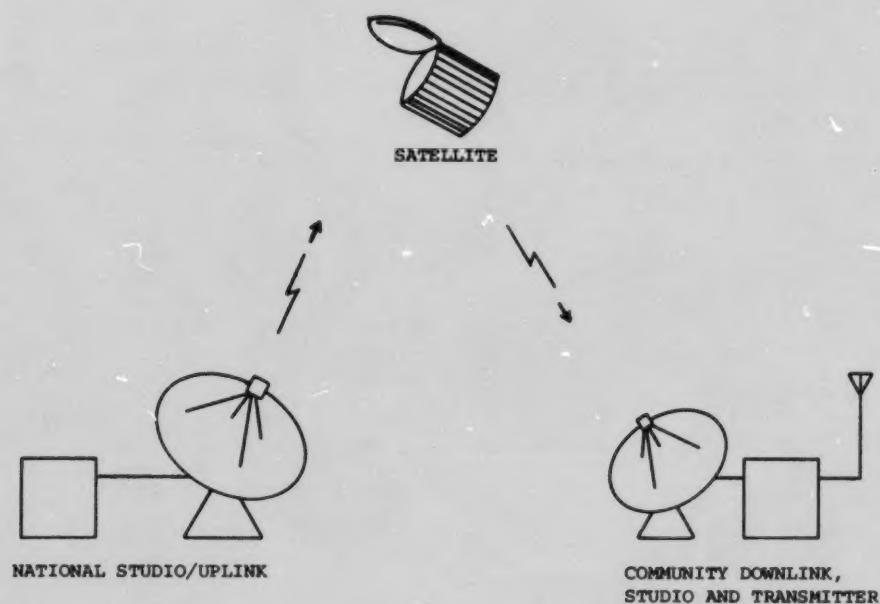


FIGURE 1. Major Components of a National Satellite Network

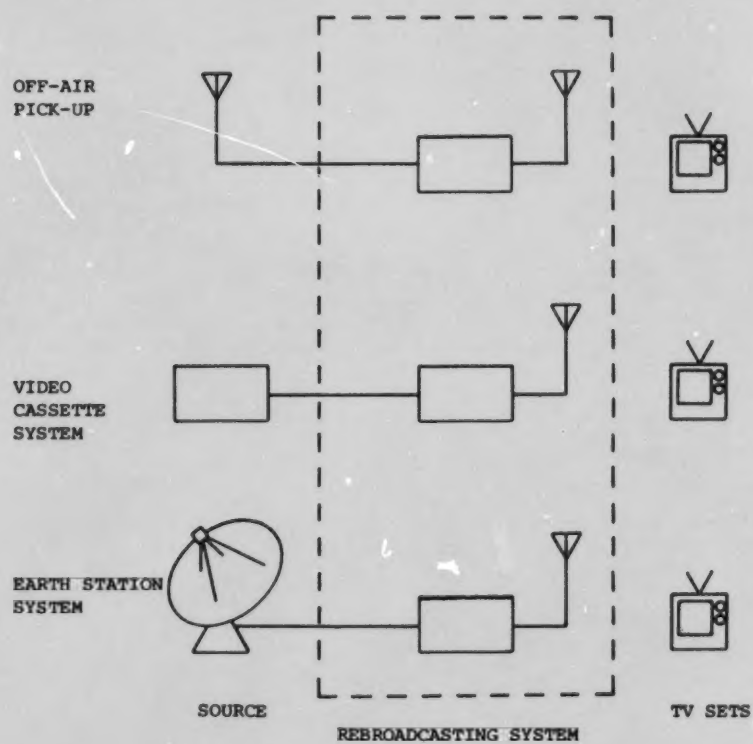


FIGURE 2. System Components at the Community Level

FIGURE 3

COMMUNITY PARTICIPATION

- Interest Shown
- Local Broadcast Association Formed
- Budgetary Costing
- Engineering Consultant Retained
- System Parameters Established
- Fund Raising
- System Ordered
- Site Selection and Preparation
- Local Civil Works
- Installation Assistance
- Operation and Maintenance

**Television Programming in the Service of
the Deprived in Developing Countries -
with Special Reference to India**

MULAKH R. DUA
Indian Institute of Mass Communication
New Delhi - 110049, INDIA

Abstract

Television set ownership in developing countries shows that elite classes possess most of the receivers. This is because there is very little fare for the poor, the deprived and the unprivileged people to watch and be benefited. Television programming also interests mostly upper class people in India, and so also in developing countries.

If television receiver ownership pattern is any indication in most developing countries, especially India, one can safely say that this is a medium for the elite. Either it has very little for the poor or the poor have scarce to look for them in it. They have greater trust in the fact that television programming has hardly anything to offer to them, and the other less privileged or the underprivileged.

Let us elaborate India's case. Official records say that television broadcasts cover 15 per cent of this country's population. The fact of the matter is that this statement is only an "arithmetical spectre". In reality, the total number of television receivers in entire India does not exceed one million. Nearly half of them are in the two metropolitan towns of Delhi and Bombay. In addition, statics of television ownership in other places where television sets are concentrated also replenishes this impression that this mass medium serves only the high and mighty, or rich and the prosperous.

This belief is further supported by the following figures on statewide television receiver ownership in India during 1978:

Statewise ownership of television receivers in India in 1978

<u>State/ Circle</u>	<u>Television Centre</u>	<u>No. of tele- vision sets</u>
Andhra Pradesh	Hyderabad	9,000
Bihar	Muzaffarpur	Negligible
Delhi	Delhi	250,000
Gujarat	Pij	5,000
Jammu & Kashmir	Srinagar	2,800
North-Western Circle	Jullundur/ Amritsar	16,000
Maharashtra	Bombay/Pune	291,000
Tamil Nadu	Madras	44,000

Uttar Pradesh	Lucknow/ Kanpur	99,000
West Bengal	Calcutta	61,000
Madhya Pradesh	Raipur	1,500
Karnataka	Gulbarga	100
Rajasthan	Jaipur	1,500
Orissa	Sambhalpur	Negligible

It is by now well-known that there are nearly 350 million people in India who are below the poverty-line, an income cut off point determined by India's Planning Commission. In such a situation, even if television has some program, for the benefit of this large chunk of population, these people would not know about them. In a country where struggle for two square meals is hard, stiff and protracted, people cannot calculate even in their wild imagination of enjoying television programming or benefiting from even radio broadcasting.

However, even the greater depression among the masses in developing nations is that television is for the upper crust of society, and it has nothing to offer to the lower rung of the society's ladder. Thus ordinarily, people in developing countries do not expect television to be able to do anything for the weak, poor, downtrodden and the oppressed.

For, this sophisticated modern medium is meant only more for entertainment, information and education. And if by performing all or any of these functions, it solves certain problems, assists someone to ameliorate his lot or improve his status so much the better. Consciously or deliberately, television programs have very little to do with the oppressed.

Picture a bonded laborer held in the tightsteel grips of a landlord, a Harijan who is not allowed to sit in the company

of caste Hindus, or a poor Moslem workers living in complete alienation. What can television do for them both qualitatively and quantitatively? My hunch is that any program dealing with any of these subjects would in the first flush not meet approval of the powers that be in the television set-up in a developing country. And if it does not chance, it will take several days to put it on the screen. For it is true that our media have hardly, if ever told, a bonded laborer, a Harijan or a poor Moslem that they are respectable human beings just as anyone of us, that they are independent persons capable of taking their own decisions and that their future cannot be predetermined by someone unconnected with them.

The fact of the matter is that our media have rarely touched this living reality and have scarcely brooded on these issues with concern or conviction and the urgency it necessitates. Although there has been a great deal of talk at all levels to improve the lot of the poor, media have yet to show any concrete interest and enterprise in this field.

It is true that print media have been taking note from time to time of the problems afflicting the weaker sections of society, the electronic media have, however, lagged far behind. Very little has trickled from television and that too in dribbles in this direction. It is true that television is a ruthless medium and lays bare the stark reality to our utter dismay in front of our eyes in our own drawing rooms. But if the medium has to become socially relevant and purposeful, it can ignore the weaker sections only at a great peril to its own credibility, feasibility and its image.

The question that now therefore should be asked is in what way can television serve the economically and socially deprived, oppressed and the religious outcasts. Before spelling out the purpose, technique and methodology by which this could possibly be accomplished, it would be pertinent to know as to what should be the objective that television authorities should endeavor to achieve and improve the plight of the poor. In other words, what sort of television programming would assist the oppressed and the deprived to raise their personality and upgrade their status in life and society? These questions are now becoming more and more relevant.

In a prolonged debate among behavioral scientists, producers and social researchers, it has been recognized that tele-

vision programming should strive to uplift the oppressed mentally and normally. They should also urge them to raise their aspirations and boost their ego. In a way, television programs should elevate their horizon and initiate them to make effort "to recover their self-respect", forge among them unity and cooperation "to community action to disrobe and discard evils".

Besides, these programs should inculcate among the socially and economically weak and deprived people "awareness of social structures, social values, awaken them to the reasons of their psychological alienation, make them reject unjust social values and lead them to enjoy feelings of liberation".

Also it would be reasonable to enable them to know and freely understand, through television, as to what matters in society and earns power and prestige. In India, why do high caste people despise low castes? How and why are they exploited? And finally, what should they do gain social respect, fame and power in society?

Although in operation for over twenty-three years now, Indian television system has not adequately realized its potential, relevance in society and its usefulness for the weak, deprived and the oppressed. However, to be able to raise its programming level to world standards, our television has indeed a very, very long way to go.

Therefore, with its constraints of tools and materials, to expect television network to achieve these goals is certainly a tall order, so to say. And there are difficulties galore at every step. Our technical equipment is old, outdated and obsolete. Another difficulty is that it cannot be replaced as black and white television technology is rapidly yielding place to color. There are other restrictions of functioning beyond a specific jurisdiction and getting clearance from the government since television is a state monopoly in India.

Not only that. There are a practical compulsions of putting the idea across on the television screen. If the theme is presented through "actors", there is every likelihood of the "reality" getting distorted or being lost sight of. On the other hand, it may be more appropriate to take the subject to the oppressed and the deprived themselves and portray them as they appear and operate on their jobs.

There is yet another snag in such programs however. The affected people on the spot will not agree to "act" in the story for several reasons: If the landlords or the "masters" for whom they work come to know, they will not only get beaten by their masters' men but will also lose their jobs and their families would be confronted with untold miseries.

Thus in order to present real life situations, none of the modern television paraphernalia such as the artistes, scripts, or the producers which normally form the heart of the program are necessary. What is really crucial is the people suffering from multifarious oppressions and being subjected to humiliating exploitation. If they are made to participate in the program, it will not only go home, but may also yield the desired results in the shape of increased goodwill and greater feeling for the unprivileged and deprived sections of our society.

Here it will be worthwhile to quote a case study of the oppressed provided by the social scientists' research team of the Space Applications Centre (SAC) at Ahmedabad in Western India.

"Bhiku is 28 years old and is a Venkar (weaver) by caste. In the cast hierarchy, he is considered slightly higher than a Harijan (outcastes). The Patels and Barajyas, who constitute the majority in the village, consider him a parish and treat him accordingly. There are eight members in his family, including his brother's wife and children. He is a drop-out from the village primary school and began working as a laborer when he was eleven years old.

"Bhiku and his brother are the only regular wage earning members of the family. They work on daily wages on a Patel's land. His daily wages are Rs. 6 (about 75 cents) during peak agricultural activity and Rs. 4 (about 50 cents) to Rs. 5 (about 60 cents) during the off-season (needless to say, there is a federal legislation known as the Minimum Wages Act). He and his brother also work in the Patel's house. As a daily wages earner, he cannot afford to take holiday on Sundays or other legal off days. He works 13 hours a day: 7 a.m. to 8 p.m. He thinks his landlord/master is a kind-hearted and generous person who not only provides him with work but also lends him money whenever he is in need. Bhiku in his does not show any ill-feeling while talking his master: nor is he aware of his total subjugation. He is

ignorant of the reality that his master and saviour is making him work more for the less than the legally stipulated minimum wage.

"Further, Bhiku is also blissfully ignorant of the psychological bond by which his master has tied him to his household peg through petty 'generosity' (loans, festival gifts, etc.) and blatant patronisation.

"Besides, working as a farm laborer, Bhiku also works as a sharecropper in another farmer's field. According to a verbal contract he has with this farmer, he gets one-fourth of the agricultural produce for all the work he does in his farm. His wife and one or two other family members also help him in this work. His wife replaces him in the first farmer's field or house, as the case may be, when Bhiku is engaged in work in the second farm. He sells the agricultural produce to whole-sale agents who visit the village regularly during the harvest season. Not surprisingly, in this transaction also he is a loser, for agents inevitably cheat him by under-weighting his farm goods or by paying him much less than the prevailing market rate of the produce.

"Bhiku is not ambitious by nature and cannot imagine what else he can do to improve his condition except to continue work in the fields, as he does now. He is firmly of the opinion that he cannot afford to pick a quarrel either with the landlord or the whole-sale buyer, for he is tied to them by loans or by other obligations."

If television were to spotlight some such problems, these programs will command a tremendous determined influence in pinching and rousing the conscience of the oppressors, agitate and activate the mind of the oppressed and may also direct reforms in the attitude of administrators. Moreover, it is clear that such a story as detailed above could not be adequately presented by television artistes. And if this had been done it would not have been so "real". In addition, attempt made in such programs would be to generate a sense of worth and virtues in an individual and, aboveall, underline the importance of his being a human. The programs may also suggest some solutions. Moreover, it would be an ideal situation to leave the whole matter to the viewer. For, it is doubtful if the television medium can be yoked as an instrument "for gaining compliance for all the ideas" presented.

It would be in fitness of things to mention here that some of the television programs prepared at India's Space Applications Centre at Ahmedabad have tried to achieve this. A 25-minute television program entitled "Zarakh" (Hyenas) in Gujarati language tries to depict extreme kind of harassment that an Harijan boy is meted out by the people of higher castes. The Harijan boy is shown (in the program) with a bicycle precariously perched on his shoulders in an unusual manner. When pressed to disclose the reasons for this, he is scared to talk about this. He however reluctantly says that when he was returning home from his college on a bicycle, some Rajputs (high caste people) objected to an Harijan boy riding on the bike on the village square. They beat him and made him to carry the bicycle on his shoulders as a punishment for his "audacious behaviour".

When the boy's father comes to know of the incident, he is non-plussed and gets a panicky. His father is indebted to the Rajputs in a number of ways. The father apologises to the Rajputs for his son's "behavior". Annoyed by his father's docile behaviour, he rides on the cycle again. After being beaten again, the boy is tortured, harassed and humiliated. To top it all, his hair is shaved off, he is paraded on the donkey with a garland of shoes in his neck.

The boy finally calls a meeting of people belonging to his community and appeals them to unite against the unjust and shoddy behavior meted out to them. The people after a great deal of excitement and debate, determine to fight out these injustices. In the end, the aggrieved community rises up in arms and is seen in confrontation against the high caste people. In the process, a woman in agony speaks up: "Yes, we should take revenge from our oppressors." Many others are seen in severe rage, and in pain.

At this stage, there is an appeal from the sky by an unknown voice to the conscience of all to do soul-searching and see who is responsible for the precipice. And how injustices, discrimination and sins can be liquidated, and what should be done to eradicate these practices.

During the last six years, the SAC has prepared about a dozen such programs depicting oppression, suppression, discrimination and tyranny the high caste people inflict on the weaker sections.

After relaying these programs, to the community viewing centres social research

chers' teams which went out to perceive viewers' reactions learned that the programs had mixed reception. While some viewers found that these transmissions would go a long way in pricking the conscience of the high caste people, other felt after depicting the atrocities weaker section people are subjected to, the program designers should have come out with some concrete solutions to match the situations.

In fact, I confronted some of these SAC researchers with these questions at Ahmedabad some time ago. They said if package remedies are offered by television, the medium may be deemed to be more of a pontificator and pedagogue and the programs will not yield any useful purpose. On the other hand, to establish its credibility, it would be apposite to pinpoint the failings and put the people's mind to work and let them find their own compromises and alternatives.

This is the only logical way. A researcher has described the facilitative role of television in most vibrating words: "Television can help focus attention on the opportunities for change, and the alternative methods and means available. Television can generate a cognitive orientation appropriate to a high-growth oriented social system by highlighting successful cases of self-reliance and ingenuity. Appropriate television program content can facilitate empathy, and thus effect a concrete contribution to modernisation. It can make people question fatalistic roles, ruts and relationships, and reconsider their acceptance of the dictates of God, Nature, the large landowner, or what have you. By producing programs with villagers' involvement, broadbased participation in decision-making can be ensured, enabling information to flow up and down the hierarchy, and horizontally among the masses. Television can confer status and create public opinion against prejudice, lethargy, inefficiency and corruption. It can form norms and attitudes where strong beliefs and resistances do not exist. It can create a climate for modernisation where initiative is encouraged, change is not feared, and hope is not lost. Alone, it cannot do much more."

Thus, television can assert its power as an agent of social change and influence in reshaping the entire gamut of high-low castes relationships and peacefully transforming the social scene. In a country of India's size, television can at the most touch a fringe of our problems and trial of adoption of a particular line of action

will take place at once.

Now that the Government of India has decided to expand television network during the next five years at a cost of about ₹ 5 million, it would be prudent for the authorities to lay down guidelines for program preparation with a view to making the medium more relevant to the poor. Unless television pays adequate attention to focus on the plight of the underdog, it will be subjected to immense criticism and even condemnation. It may even be ignored. And there is no greater punishment for a mass medium than being ignored by the community it seeks to serve.

NEW TELECOMMUNICATIONS POLICY IN THE U.S.:

WHO BENEFITS? WHO DOESN'T?

Herbert S. Dordick
Patricia Lum
Annenberg School of Communications
University of Southern California
Los Angeles, CA

The United States has begun the restructuring of its communications industry. The recent decision to deregulate the telephone monopoly in exchange for its divesting itself of twenty-two of its operating companies is the first step in what will very likely be a long process of policy re-evaluation.

The forces that are creating this major change in direction are not solely that of technology for they include a significant ideological thrust toward a free market for communications for which the all encompassing word, "deregulation," has been used. Deregulation, in reality, is a shift of regulatory responsibility to other power and governmental centers. States will now have to bear the major burden of regulating telecommunications in an environment that does not favor rational argument. The market will resolve these issues, so says the Congress by its inaction. And AT&T resolves the dilemma by calling for a rational rate structure to be developed in the most irrational of policy environments, state government.

During the next several years we can expect significant increases in local telephone rates and equally significant differences in the quality of service among operating companies as they seek sources of financing and negotiate rate increases with their respective state public utility commissions. In this respect, the telephone services in the United States may soon resemble that of several European nations. Perhaps most critical of all is the probable breakdown of the principal of universal service at affordable cost incorporated in the Communications Act of 1934. This section was included in our communications laws because of lively debates in Congress about the need to further explicate values of free speech and press of our Constitution with respect to a broadcasting context.

It is almost inevitable that the Green Decision in 1982 will be revisited within the next five years. Three possible outcomes of such an inquiry are:

- 1) Re-regulation of the industry,
- 2) Deregulation of the local operating companies,
- 3) Stay the course.

We expect that the most likely to occur will be the deregulation of the local operating companies, allowing them to enter into other businesses that offer additional local loop service options.

This will put the local operating telephone companies on a collision course with the broadcast and cable television industries.

They, too, are presently in the throes of change. Network viewing has declined by almost 20% since the advent of cable television, video-disks, and video cassettes as well as video games. Expectations of the diversity that cable could offer have not been met and the coming industry "shakedown" will doubtless see increasing concentration of ownership with the broadcasters moving to preserve their oligopoly by buying into cable. Finally, the local operating companies can be expected to seek access to cable channels and systems, to newly available microwave frequencies and other broadcast spectrum in order to be able to offer more diverse and profitable local loop services. Broadcasters will also seek access to the telephone market through their entry into mobile telephone services via cellular radio.

While the industry restructuring has not yet begun in the broadcast and cable industries, (although attempts to deregulate cable have been underway but so far have failed), we can expect the debate concerning broadcasting will also take place within the next five years and will focus on the following options:

- 1) De-regulation of all broadcasting (as currently suggested by FCC Chairman Fowler).
- 2) Increasing regulation along new lines including:
 - a) A common carrier policy for broadcasting and cable, and,
 - b) More stringent regulations concerning cross-ownership,
- 3) Stay the course.

One thing is certain, however, and that is that for the first time in fifty years, communications policy will be on the national agenda.

Recent Trends in the Japanese Telecommunications Policies

Yuuichi Ito
Institute for Communications Research
Keio University
Tokyo, Japan

1. Abstract

The three basic trends and issues in the recent Japanese telecommunications policies, i.e., (a) division and privatization of the Nippon Telephone and Telegraph Corporation (NTT), (b) deregulation and introduction of competition in enhanced telecommunication services and (c) "new media" development and diffusion policies, are discussed in the light of four basic postulates, i.e., policies change (1) when the priority among goals changes, (2) when the meaning of a goal changes, (3) when some new goals are added and (4) when the effectiveness of means to achieve the goals changes. These four postulates are again used to explain the commonalities and diversities seen in recent telecommunications policy problems in major industrial countries.

2. Introduction - Definitions

In a previous article I defined communication policy as "administrative, judicial and legislative measures taken to achieve social goals through communication" (Ito, 1982:272). Telecommunications policy is only one part of an overall communication policy. If we understand telecommunication as communication by electronic media, telecommunications policy can be defined as administrative, judicial and legislative measures taken to achieve social goals through the electronic media.

3. Historical Backgrounds and Current Issues

When Japan initiated telegram in 1870, the Japanese private industries were so feeble that there were no claims that telegram should be operated by private hands. It naturally started as a direct government enterprise. However, when telephone was introduced into Japan in 1878, there were some business interests who wished to undertake the telephone business and some sympathizers in the government (the Ministry of Finance which worried about huge amount of investment for this new enterprise). As a result, controversies about the management form of telephone business lasted for twelve years until the government finally decided in 1890 that telephone should be operated under direct government monopoly as in the case of telegram.

The major reasons for government monopoly were:

- (1) Preservation of secrecy of communication by military, police and other government agencies.

- (2) Under private management, investment will be made only in urban areas and diffusion to rural areas will be delayed.
- (3) Telephone in most foreign countries except the United States are operated under government monopoly.

Similar controversies arose again when Japan decided to initiate radio broadcasting in the early 1920s. Since around 1922, various private interests such as manufacturers and distributors of electrical equipment, newspaper companies and news agencies began to express their wishes to initiate broadcasting business. In 1924, however, the Ministry of Communications summoned major applicants for broadcast licenses and announced that:

- (1) Source of revenue for broadcasting business should be the receiver fee and not advertising.
- (2) The management of broadcasting should be by nonprofit seeking organizations.

This decision, particularly the second point, was a great disappointment for private businessmen. Therefore, controversies lasted long even after this decision was made. In 1924 three nonprofit seeking broadcasting stations began service in Tokyo, Osaka and Nagoya. In 1926, however, the Ministry of Communications recommended that these three stations should be merged to form one national organization. Although the three stations strongly resisted against this policy, this merger was forced with the condition that a certain degree of autonomy would be left to these three stations. Thus, the Corporate Juridical Person, the Nippon Hoso Kyokai (NHK) was established in August, 1926.

After World War II, the government judged that common carrier business had grown too big to be directly managed by a government regulatory agency. Therefore, they decided to separate it from the regulatory agency and make it independent as a special public corporation. Thus, in 1952 the Nippon Telephone and Telegraph Corporation (NTT) was established for domestic services, and in the following year, 1953, the Kokusai Denshin Denwa Co., Ltd. (KDD) was established for international services.

Although the Americans at the General Headquarters (of Allied Forces) were enthusiastic about "democratization" of NHK, they were not so enthusiastic about the introduction of the American-style commercial broadcasting system. Apparently, they thought that monopolistic NHK was more convenient for smooth implementation of their occupation policies. However, the demand for commercial broadcasting particularly from newspaper companies which, as mentioned before, existed even in the 1920s became so strong that the government decided to permit their entry. Commercial radio started in September 1951, and commercial television in 1953. Thus, competition between BBC-type public broadcasting and American-type commercial broadcasting, a system unique in the world, started in Japan.

In the mid 1960s, various new kinds of telecommunication media such as data communication and facsimile communication began to diffuse, and together with the expansion of the computer industry, rapid expansion of various forms of information services were projected. Then, those private companies who used NTT's (Nippon Telephone and Telegraph Corporation) communication circuits or planned to install their own circuits for data communication and various information services began to demand the amendment of restrictive laws and regulations concerning the use and installation of communication circuits. These demands by private companies were supported and pushed by the Ministry of International Trade and Industry (MITI) because one of the pillars of MITI's strategy since the early 1970 has been to strengthen the information and communications industries as Japan's main "strategic industries." We will further discuss this point later.

In order to better cope with this situation, MPT created a special section named the Telecommunications Policy Division in 1971 for planning and execution of telecommunications policies other than broadcasting. In its brief tenure this Division has completed some well-known projects such as the Information Flow Census, the Tama CCIS (Coaxial Cable Information Service) experiment and the CAPTAIN (Character

And Pattern Telephone Access Information Network System) experiment. This Division was later expanded and strengthened, and in 1980 it became the Telecommunications Policy Bureau.

Despite such achievements and organizational expansion, Japanese telecommunications policies still lack consistent, systematic theories or philosophies as a basis for actual policies. This may be because telecommunications policy has not yet been generated in a consistent fashion. Rather, it has just tended to be an ad hoc collection of responses to demands by the private information industries and compromises between the MPT group (MPT, NTT and KDD) and the MITI group (MITI and the private information industries).

Of course "compromise," which policy makers usually call "adjustment," is a feature of every kind of policy. However, if a policy should be nothing but a collection of responses and compromises, that policy could end up as a confused and chaotic patchwork. When Japan was still a developing country, it avoided such confusion or chaos by learning and borrowing from the experiences of more advanced countries. Now however, Japan is one of the most advanced countries in telecommunications, and it can no longer wait and see what will happen in other countries. Japan must now plan and experiment by itself in the forefront of such complicated areas. These were the initial reasons that led to the establishment of the Telecommunications Policy Division in 1971 and its expansion as the Telecommunications Policy Bureau in 1980.

In October 1980 a special task force for the Minister of Posts and Telecommunications named the Telecommunications Policy Council composed of many experts in business, academics, telecommunications and mass media was organized by the initiative of the Telecommunications Policy Bureau. The chief mission of this Council was to clarify guidelines for Japanese telecommunications policies in the 1980s. The final report of this council entitled Telecommunications Policy As It Ought To Be in the 1980s was published in August 1981. The major points recommended in this report were as follows.

- (1) Basic facilities such as nationwide and international communication circuits should be monopolistically provided by NTT and KDD for the most effective use of resources and prevention of double investment.
- (2) Basic common carrier services such as telephone and telegraph should continue to be monopolistically provided by NTT and KDD.

- (3) However, as for enhanced services such as data communication and various forms of information services, the deregulation policy which started in 1971 should be further promoted. In these areas competition should be encouraged.
- (4) Appropriate measures should be taken to overcome vulnerabilities of information societies such as to protect privacy and other stored data and to prevent computer crimes.
- (5) Efforts for the development and diffusion of "new media" and new media systems such as videotex systems and community information systems utilizing sophisticated multi-purpose cable television should be continued.

On the other hand, more drastic policy changes had been discussed at a more powerful advisory committee for Prime Minister named Provisional Commission for Administrative Reform established in 1981 to reform governmental enterprises and public corporations including NTT. This Commission published in July 1982 their final report which suggested that NTT should be divided into several "regional" joint-stock companies and a "central" joint-stock company which takes over NTT's national trunk lines and research institutes. Regional monopoly is guaranteed for the regional companies but monopoly is not guaranteed for the central company.

After all, recent issues of telecommunications policies in Japan can be roughly classified into the following three categories: (a) Division and privatization of NTT, (b) deregulation and introduction of competition in enhanced telecommunication services and (c) "new media" development and diffusion policies.

4. Four Hypotheses to Explain Recent Trends in Japanese Telecommunications Policies

According to my definition of telecommunications policy, I believe that any policy should always be considered in terms of goals and means. I would like to discuss the above-mentioned three basic current issues and trends in Japanese telecommunications policies in terms of four basic postulates.

Hypothesis 1. Policies change when the priority among goals changes.

Before World War II, military secrecy was one of the most important reasons for keeping common carriers under strict government control. Nowadays, however, the military have developed their own communication networks, and they no longer rely upon common carriers so much as they used to

in old times. Therefore, military secrecy is no longer an important goal, and other goals have been advanced in the list. Similarly, expansion in terms of reach and availability has long been a major goal of the Japanese telecommunications policy. An additional motivation was to catch up with more advanced countries. However, this goal has been almost completely achieved, and mere expansion can no longer be a primary goal and can no longer be used to justify policy. However, if that basis is lost, the position which supports monopoly becomes weakened.

Hypothesis 2. Policy changes when the meaning of a goal changes.

One major goal of telecommunications policies has long been: "to provide communication facilities to meet social needs for communication" (Miura, 1977: 3). Traditionally, this "social needs for communication" has been simply defined in terms of quantity—for example, the number of telephone receivers per 100 population, etc. Recently, however, the "social needs for communication" has taken on a number of other meanings. In addition to traditional needs for telephone and telegraph, new needs for facsimile, videotex, data telephone, data communication and various forms of information services were born and are growing. Therefore, nowadays we can say that when we say "needs for communication," it means not only quantity but also quality i.e., diversity. This means that even if we describe the primary goal of telecommunications policies in the same way as before, i.e., "to provide communication facilities to meet social needs for communication," the emphasis has apparently shifted from a matter of quantity to that of quality or diversity. In such a situation, the means to achieve the goals, which are policies, inevitably change.

Generally speaking, monopolistic corporations are suited for large-scale, simple and fixed services and less suited for diversified, flexible services. Laws and regulations that bind monopolistic corporations are of course one of the major reasons for this state of affairs. However, mere size can also be a serious obstacle for diversified flexible services. This is one of the arguments of those who are seeking privatization and/or division of NTT. Because the meaning of social needs has been expanded to include a need for more diversified services, policy changes must follow.

Hypothesis 3. Policies change when new goals are added to the initial set of goals.

The idea of fostering the information-related industries as a country's strategic industry

was not common in any country's telecommunications policies before the 1960s. Nowadays, however, this idea has been included in the telecommunications policies of most industrialized countries.

In Japan this goal has been emphasized since the middle of the 1960s particularly in reports and recommendations from MITI and MITI's advisory groups such as the Sangyo Kozo Shingi Kai (Industrial Structure Council). In the mid 1960s, faced with serious industrial pollution inside Japan and tough competition with newly industrialized countries such as Korea, Taiwan and Singapore, Japanese economic policy makers began to feel that the Japanese industrial structure as a whole should become specialized in more pollution-free, knowledge and technology intensive industries. Thus, in the late 1960s and early 1970s policies were developed and implemented to strengthen the Japanese information and communication industries. They were called the *johoka* or "informationalization" policies. The French learned much from such Japanese *johoka* policies and created a French version, the *telematique* policies in the late 1970s.

The Japanese information and communications industries and MITI have long insisted on deregulation of communication circuits for data communication and enhanced telecommunication services as a means for development. On the other hand, both MPT and NTT have been reluctant about deregulation. They claimed that safe and stable public service might be disturbed and jeopardized. Some part of such claims, however, might be their rationalization because they are afraid that their "territory" becomes eroded. Still, however, MPT could not deny the importance of fostering and strengthening the Japanese information and communications industries. Although it might not be MPT's chief concern, this goal must at least be considered in policy decisions. Nowadays not only industrial policies but also science and technology policies such as national development plans for rockets are related to telecommunications policies particularly in satellite communication policies. Addition of such new goals has apparently made telecommunications policy making more complex and difficult than before.

Hypothesis 4. Policies change when the effectiveness of means to achieve the goals changes.

Policy makers have long believed that monopoly best serves public interest particularly in basic services such as telephone and telegraph. This idea has traditionally been justified by the theory of natural monopoly. This theory could be justified when the resources for basic telecommunica-

tion services were wire and microwave networks. Nowadays, however, technological development has brought other kinds of resources for common-carrier-like services. Domestic communication satellite, sophisticated cable TV systems, inexpensive optical fiber cables are such examples. As resources become abundant and diversified, the appropriateness of monopoly becomes questionable. This tendency has been seen in the histories of various other communication media. The relationships between abundance in resources, time (which brings technological development) and regulatory policies are shown in Figure 1.

Figure 1. Time, abundance in resources and regulatory policy (in Japan)

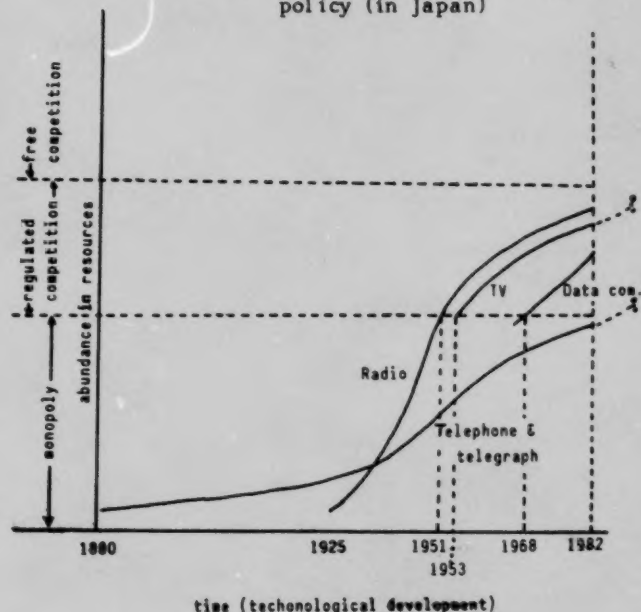


Figure 1 shows that as time goes by, technology develops, and as technology develops, abundance in resources increases. As abundance in resources and the diversity of means to achieve goals increase, the advantage of natural monopoly decreases. And, in many cases, the merit of competition increases. Therefore, policy changes from monopoly (which means full regulation) to regulated competition (including competition between public and private sectors as seen in the Japanese broadcasting, railroad and data communication), and after a certain point, to complete free competition. Of course, actual policies are also determined by various irrational factors such as political maneuvering among various pressure groups. Therefore, it is impossi-

ble to project the end of monopoly or regulated competition and the beginning of regulated or free competition. Figure 1 is only a simplified model to give a rough idea of the relationships between technology, abundance in resources and regulatory policies.

5. Conclusions

Finally, I would like to discuss some of the commonalities in situation and diversities in policies among the advanced industrialized countries. An obvious commonality in situation is the fact that the telecommunications policies in those countries are all in a state of flux. As a Japanese policy maker put it at a symposium, "We are now at an exciting time." One of the main reasons for this turmoil is the drastic example set by the United States. However, it would be too superficial to regard the present situation in other industrial countries as a mere fad caused by American policy changes. I believe that the changes in other industrialized countries are more structural and genuine.

In this article we have discussed recent changes in the Japanese telecommunications policies in the light of four postulates. If we look carefully, we can find examples from many countries that match the conditions set forth in such postulates. While I have stated most of my postulates in terms of goals and means, it is apparent that all are based on basic changes brought about by technological innovation.

Although telecommunication policy makers in major industrialized countries are faced with similar decisions, namely, monopoly or competition, public or private management and development and diffusion of "new media," the directions of decisions seem quite diversified among these countries. While the direction of American, Japanese and British policies is definitely toward deregulation, more competition and privatization, that of France is opposite—nationalization and more strict monopoly—and the direction of West Germany seems undetermined. If we included developing countries in our consideration, diversity of telecommunications policies on a worldwide scale would be enormous. I think such diversity can be explained by modifying the four hypotheses discussed above.

- (1) Difference in the rank order of priority among policy goals given by the society (modification of Hypothesis 1).
In some countries the nationwide telecommunication networks have already reached a saturation point whereas

in some other countries they have not. In some countries military considerations determine policy, but in others they do not.

- (2) Difference in the meaning of (the same) policy goals (modification of Hypothesis 2). In some countries "communication needs" are considered in quantitative terms whereas in some other countries they are considered in qualitative terms such as diverse service.
- (3) Difference in the list of policy goals (modification of Hypothesis 3). Among industrialized countries the United States was the last in adding the goal of fostering information-and-communication-related industries as a strategic industry. Japan has done this for at least ten years and Western European countries for several years.
- (4) Difference in the effectiveness of means to achieve the same goal (modification of Hypothesis 4).
Even if the goal is the effective use of resources, there might be some social, economic and political conditions which make free competition most effective in the United States, nationalization in France and some other European countries and "mixed competition" (competition between public and private sectors) in Japan.

For whatever cause, I believe that it is always important to consider telecommunications policies or any policies in terms of social goals (which inevitably become policy goals) and means to achieve them. When there are not many social goals in relation to a particular policy, the number of means to achieve the goals are naturally limited; therefore, the policy can be simple and easy to understand. However, as the number of relevant social goals increases, the number of means to achieve the goals increases exponentially. Furthermore, the means to achieve the goals conflict with each other. Thus, the policy making becomes more complex and difficult. This is what many industrialized countries are now experiencing. Thus, the need for more telecommunication experts and systematic theories for telecommunications policies is growing: The age of policy making based upon past experience and intuition seems to be ending.

NOTES

- (1) For detailed information concerning this Census, see Youichi Ito, "The 'Johoka Shakai' Approach to the Study of Communication in Japan" in G. C. Wilhoit and H. de Bock (eds.), Mass

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- (2) For detailed information concerning these experiments, see the following literature.
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- Masuda, Yoneji, The Information Society. Tokyo: Institute for the Information Society, 1980.
- (3) A remark by Tetsuro Tomita, Deputy Director General, Telecommunications Policy Bureau, MPT in his speech at an international seminar entitled "Perspective on Comprehensive Telecommunications Policy in Transition" held in Tokyo on October 25-27, 1982.

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THE TELEMATIC SOCIETY: IMPLICATIONS FOR THE PACIFIC REGION

Indu B. Singh and Laura Conroy
Rutgers University

Abstract

This paper sheds light on the emergence of the telematic society and its implications for the Pacific region. The possibility of a widening "information gap" between the nations of the region has been explored. Specific suggestions have been made regarding a guided development of the telematic society in the Pacific region.

The telecommunications revolution is upon us. The industrialized nations of the world are preparing rapidly to enter into a post-industrial era. In the United States, for example, new telecommunication technologies are influencing the nature of the country's workforce, national economy, cultural, educational and political processes, as well as human communication behavior. It is estimated that by the year 2000, about 66 percent (two-thirds) of the workforce in the United States will be allied with information and knowledge industry.

In some industrial nations including the United States, the revolution in the communication industry has given birth to the "telematic society" -- a society based on the combined influence of telecommunications and computer. And one finds this encouraging trend burgeoning on a global basis. This is one powerful change that is bound to engulf all nations -- rich and poor, big and small, industrial and non-industrial. Although the impact of telematics will vary from one society to another, the Pacific region must prepare to embrace this change now.

The concept of "telematics" is gaining popularity worldwide. This term stems from a similar term called "telematique" coined in France to highlight the convergence of telecommunications and data processing. Telematics doesn't represent any unique technical system or the technology per se. It simply signifies a very carefully chosen strategy to harness the combined effects of advances in computers and telecommunications for everyday communication and information needs.

Despite the universal recognition of the significance of information and communication for economic growth, socio-cultural progress and educational advancement, the current national and international trends in telematics and informatics indicate that many countries in the Pacific area may not be able to match the post-industrial environment of industrialized nations. This may lead to a real danger of the telematic society -- a society and the region divided in terms of "information rich" and "information poor."

This paper raises some penetrating questions on this issue and attempts to provide several concrete suggestions for the development of the telematic society in the Pacific region.

The Emerging Telematic Society and the Pacific Region

The Pacific region is a collection of over 50 countries, territories and independent possessions representing almost half of the world's population. These nations are very diversified in terms of the density of population, geographical size, levels of economic development, literacy and educational level, and the advancements in telecommunications and information industry. The Pacific region provides examples of some of the most advanced as well as least advanced nations in the world, especially in terms of telecommunications and information capabilities. Because of this diversity and extremes, sweeping generalizations about the region are difficult to make. The following comments are general and must be applied to specific nations of the region very cautiously.

The future development of telematics in the Pacific region can be viewed in two major contexts. They are: (a) the socio-economic context, and (b) the international tele-political context. The socio-economic context involves such considerations as financial investment, technological innovations, technology transfer, experiments with new information and communication systems, as well as telecommunications infrastructural development, planning and policy. The international tele-political context, on the other hand, pertains to the management of the electromagnetic spectrum, the geostationary satellite orbit, international development aid, and domestic regulations affecting international tele-environment. The following discussion sheds further light on these two broad contexts of the development of the telematic society in the Pacific region.

The Socio-Economic Context: A quick look at the past indicates that there have been some significant attempts made by the Pacific nations to enhance their communication capacity. For example, financial investments (both domestic and international) in telecommunications have gradually increased. Some nations have emphasized innovations in indigenous telecommunication systems as well as the transfer of appropriate technology.

Some of these countries have experimented extensively with new telecommunication systems for education, health and family planning, and national development. Despite these seeming successes, it is evident that there is an increasing gap between the nations of the Pacific region in terms of their ability to process, store and transmit information. Why is this "information gap" widening? Who is accountable for this uneven growth in the communication industry of the Pacific region?

There are no direct answers to these questions. There is no one factor or nation that could be singled out and held responsible with any stretch of our imagination. However, it is our position that some countries may have been victims of their own telecommunications policy and planning. The traditionally prevalent attitudes toward information and communication, viewed as being less important than other national priorities, have thwarted a desirable level of growth in the telecommunications sector. Surely, economic and technological factors have not favored the poor countries of this region. Nevertheless, the attitudes of their social and political elites toward developing more modern telecommunications infrastructure remains a paramount concern. Every possible consideration with regard to telecommunications development indicates an urgent need for these leaders to develop positive attitudes and aggressive indigenous agenda.

The major obstacles that could lead to an artificial slowdown of the telematic society in the Pacific region are:

- Inadequate policy and planning for increased international cooperation;
- Inadequate allocation of financial and other resources;
- Parochial regulatory attitudes of governments; and
- Excessive fears of cultural imperialism and the resulting overcontrol of telecommunications technology and information flow.

Many information age technologies are available now. Their efficient and appropriate applications by the Pacific nations could lead to many desirable developments. It would be wise for these countries to take a hard look at today's pragmatic realities rather than clinging to the perspectives of the past. It is wrong to rationalize that history repeats itself. This is one instance in which the future seems more salient than the discussions of the past. The future is today, not tomorrow.

International Tele-Political Context: Development is a process that requires some form of interdependence of nations and the sharing of their resources. Telematics development in the Pacific region in particular will need such international cooperation on a priority basis. The primary need for cooperation with industrial nations (both

within and outside the Pacific region) are in areas of financial aid and investments, technology transfer, infrastructure development and experimental projects. Such cooperation, if developed on the basis of mutual trust and respect, will benefit all parties involved. It must be kept in mind that industrial nations can benefit significantly from the growth of the telematic society in the Pacific region.

Perhaps no other single factor in developing Pacific regions' telecommunications can be deemed so rudimentary as a fair and equitable distribution of radio frequencies and the geostationary satellite orbit. In the past, industrialized nations have enjoyed an unquestioned status with regard to the uses of these two resources. The International Telecommunication Union's frequency allocation practices, i.e., first come, first serve, have generally favored the nations with technological superiority. A similar situation has existed with regard to the use of the geostationary orbit. Now, the times have changed. Many nations are demanding a new approach to the management of these international resources, and rightly so. They are asking for a priori long plans so that when their needs arise, they will have these precious resources available. The 1980's will witness a series of key decisions relating to the problems of radio frequencies and the geostationary orbit, especially in view of ITU's World Conference that will take place in various parts of the world until 1988. The outcome of these international deliberations will greatly influence the growth of the telematic society in the Pacific region as well as elsewhere.

Conclusions and Suggestions

In sum, the problem of a widening "information gap" between the rich and poor nations of the Pacific region is a serious one and must be viewed with utmost concern. The responsibility to find reasonable solutions for this lies as much on the collective wisdom of the Pacific nations as it does on the industrialized countries. In view of this problem, we propose the following policy-oriented suggestions:

1. There is an urgent need for recognizing telecommunications as a vital part of the national economic growth in the Pacific region. This recognition must be reflected in attitudes and policy decisions of their social and political elites toward the value of information and communication for development purposes.

2. In view of the problems of urban living all over the world, the development of rural telecommunication systems should be a major concern especially in the less developed nations of the region. The rural satellite communication projects developed by the USAID seems to be a step in the right direction. The scope of such programs should be widened. Also, there seems an urgent need for increased financial support from industrialized nations and international development agencies such as the World Bank, ITU, UNESCO,

USAID, etc.

3. Governments of the Pacific nations alone cannot bring about a rapid growth in the telecommunications and information industry. It is imperative that private sectors in these countries and perhaps outside the country are brought in as a vital partner.

4. The development of telecommunication policies and systems should be geared toward creating sorely needed employment opportunities for the younger generation of the Pacific nations.

5. And finally, as the various meetings of the International Telecommunication Union take place in this decade, it must be clearly recognized that the first come, first serve strategy of frequency distribution no longer serves the interests of the less developed nations of the Pacific region. A more appropriate and acceptable formula for an equitable distribution of the electromagnetic spectrum and geostationary satellite orbit must evolve.

Space Communications in Japan

Tadahisa Mori
Ministry of Posts and Telecommunications
Japan

1. Abstract

This paper outlines some of the planned satellite communication projects in Japan over the next 5-7 years. In addition, Japanese space development policies are set out along with a historic review of the development of artificial satellites.

1. SPACE DEVELOPMENT IN JAPAN

Space development activity in Japan has been performed on the basis of the following policies:

(1) To develop artificial satellites by means of our own country's capacity, and to maintain technical art and skill enough to launch them by means of our own country's capacity;

(2) To practice space development in relationship to higher programs in terms of the necessity, urgency, and economics within the range allowable within the national capability; and,

(3) To take partial charge, within our means, to actively participate in the international space development activity, such as large-sized space station projects or others.

In Japan, along with these policies, we have been developing communication satellites, direct broadcasting satellites, meteorological satellites, scientific and remote sensing satellites, and so forth. The vehicles for placing these satellites into orbit include M, N-I, N-II launch vehicles.

From 1970 to 1982, we have launched 24 satellites. Twenty-two of these have achieved predetermined orbits. This includes three satellites which were launched by the United States Delta launch vehicle. Sixteen satellites are planned to be launched during and after 1983. These satellites are shown in Table 1. The larger-sized N-I vehicle will be used to launch these satellites. The grand total by the end of the 1982 fiscal year for the expenses required for developing and launching these satellites, the launch vehicles, tracking, constructing launch sites, and so forth, total approximately one trillion yen. Figure 1 shows the budget for space activities broken up by governmental and non-governmental sources

2. COMMUNICATION SATELLITES

Japan has done some basic-line thinking concerning domestic communication satellites. A survey of domestic telecommunication has been done by the domestic public telecommunication common carrier (NTT) and others. These include the National Police Agency, Ministry of Constructions, Japan

National Railways, etc. Nippon Telegraph and Telephone as a public corporation has constructed a telecommunication network serving all parts of the country. In 1978, the entire nationwide telephone network was capable of being automatically dialed. Delays concerning installation of subscribers' telephones were entirely dissolved. In other words, the goal of domestic telecommunication is to improve its quality and service. Therefore, communication satellites in our country are not to be applied for supplementing shortage of aboveground circuits, but are available, if necessary, if above-ground circuits are broken off by disasters, etc.

If any multi-beam communication satellites or switching are developed in the future, they could be used on an extensive scale along with microwave, coaxial, or optical-fiber cables.

2.1 OPERATIONAL COMMUNICATIONS SATELLITES PROJECT (CS-2)

CS-2(2a and 2b) are planned to provide the first operational domestic satellite communication system in Japan and are planned to satisfy multiple missions requested by various organizations (NTT, National Police Agency, Fire Defense Agency, JNR, etc.). The satellites are being developed at NASDA and will be launched by a Japanese launch vehicle N-II in the first and third quarters of 1983.

(1) Mission Objectives of CS-2

- to secure telecommunication services in case of natural disasters or emergencies;
- to establish communication link for remote islands and isolated areas in the Japanese territory;
- to provide temporary transmission links; and,
- to develop the technology of the communication satellite.

(2) CS-2 system

CS-2 is a spin-stabilized geostationary

Table 1

Satellite to be launched in future

(a) Application Satellite

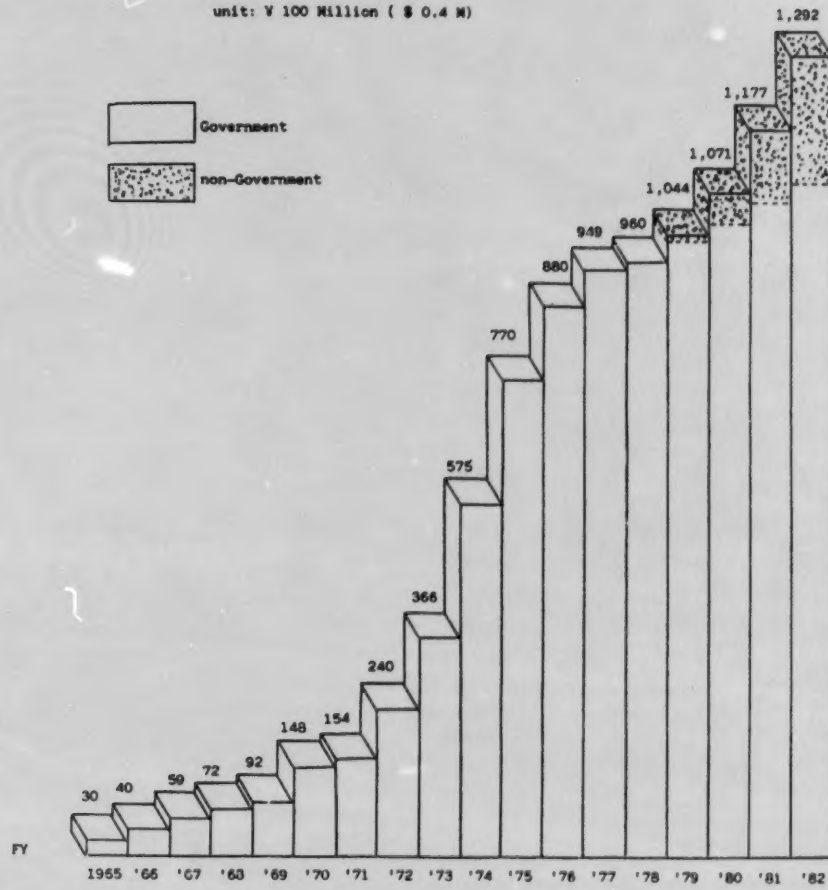
Satellites	Weight (kg)	Orbit			Launch Vehicle	Launch Date	Frequency
		Shape	Altitude (km)	Inclination to equator (degrees)			
Communications Satellite-2 (CS-2a, CS-2b)	350	Geostationary orbit		(132 E.Long., 136 E.Long.)	N-II N-II	FY 1982 (CS-2a) FY 1983 (CS-2b)	6/4 GHz 30/20 GHz
Broadcasting Satellite-2 (BS-2a, BS-2b)	350	Geostationary orbit		(110 E.Long.)	N-II N-II	FY 1983 (BS-2a) FY 1985 (BS-2b)	14/12 GHz
Geostationary Meteorological Satellite-3 (GMS-3)	290	Geostationary orbit		(140 E.Long.)	N-II	FY 1984	400/470 MHz 2/1.7 GHz 2.1/2.3 GHz
Marine Observation Satellite-1 (MOS-1)	750	Sun-synchronous orbit	900		N-II	FY 1984	400 MHz/ 2 GHz, 8 GHz, 1.7 GHz
Engineering Test Satellite-V (ETS-V)	550	Geostationary orbit			H-I	FY 1987	1.6/1.5 GHz 5 GHz
Communications Satellite-3 (CS-3a, CS-3b)	550	Geostationary orbit		(132 E.Long., 136 E.Long.)	H-I H-I	FY 1987 (CS-3a) FY 1988 (CS-3b)	6/4 GHz 30/20 GHz
Broadcasting Satellite-3 (BS-3a, BS-3b)	Unsettled	Geostationary orbit		(110 E.Long.)	Unsettled	FY 1988 (BS-3a) FY 1989 (BS-3b)	14/12 GHz
Earth Resources Satellite-1 (ERS-1)	1,500	Sun-synchronous orbit	550 570		H-I	—	400 MHz/ 460 MHz, 1.7 GHz 8 GHz, L Band
First Material Processing Test (FMPT)	—	Participate in the Space Lab Mission			—	around FY 1987	

(b) Scientific Satellite

Satellites	Weight (kg)	Orbit			Launch Vehicle	Launch Date	Frequency
		Shape	Altitude (km)	Inclination to equator (degrees)			
The Ninth Scientific Satellite (EXOS-C)	200	Elliptic	300 1,000	65	N-3S	FY 1983	148 MHz/ 400 MHz, 2.2 GHz
The Tenth Scientific Satellite (PLANET-A)	125	Heliocentric orbit			N-3SII	FY 1984	2.1 GHz/2.3 GHz
The Eleventh Scientific Satellite (ASTRO-C)	400	Circular	500		N-3SII	FY 1985	148 MHz, 2.1 GHz 400 MHz, 2.2 GHz
The Twelfth Scientific Satellite (EXOS-D)	300	Elliptic quasi- polar orbit	400 10,000	70	N-3SII	FY 1986	148 MHz, 2.1 GHz 400 MHz, 3.2 GHz 8.4 GHz
Space Experiments with Parti- cle Accelerators (SEPAC)	—	Participate in the first Spacelab Mission			—	FY 1983	

Figure 1. Budget for Space Activities

unit: ¥ 100 Million (\$ 0.4 M)



satellite and will be placed at 132°E(2a) and 136°E(2b). NASDA is responsible for launching and maneuvering until an initial check up in the geostationary orbit and then a new organization (Telecommunication Satellite Corporation of Japan) will operate and control the satellite with its TTC&M center near Tokyo.

CS-2 has two C-band transponders (180 MHz at 6/4 GHz) and six K-band transponders (130 MHz at 30/20 GHz). The "footprint" is shaped to cover the Japanese main islands with the beam-edge gain of 33dB at 30/20 GHz and to cover all Japanese territories with the beam-edge gain of 25 dB at 6/4 GHz. It is understood that 30/20 GHz signals are subject to attenuation by rainfall more than 14/11 GHz but are utilized in order to avoid interference from terrestrial networks operating at 11 GHz. Expected continuity of the service at 30/20 GHz without a site diversity will be 95% in a year with the present system design (Table 2).

(3) Network Configurations

1) Public telecommunication (NTT)

Two C-band transponders (mostly for links to remote small islands) and four K-band transponders (for supplementary networks within the main islands) will be allocated for public telecommunication. The configuration of satellite links has not been finalized, but one possible example is as follows: Eight central earth stations (10m parabola antenna) in Tokyo, Osaka, Sapporo, and other locations, will be operating to carry overflow traffic in 30/20 GHz range during the congested period and to serve for an occasional TV transmission for major events. These central earth stations will also be used to establish temporary links with multiple transportable earth stations (offset parabola antenna 3.3m) and vehicle-mounted type earth station (2.7m parabola) throughout Japan. C-band will be used for local links between the central earth stations in the mainlands and small earth station in isolated small islands such as Ogasawara.

11) Satellite Communication for public agencies

Two K-band transponders will be assigned for various services for several government agencies, Japan National Railway and the electric power companies. Even though each organization has separately constructed their own nationwide microwave communication network, additional satellite communication fixed earth stations seem to be useful to secure telecommunication services in case of national disasters and to establish communication links for remote islands. In addition to these purposes, some agencies such as NPA have intended to use the satellite communication network for video transmission from spots where disaster or accidents occur to appropriate headquarters. This will be accomplished by using a portable earth station and video cameras.

111) Domestic Communication Satellite Projects in the Future

The Ministry of Posts and Telecommunications is now testing Japan's second generation communication satellite, CS-3. The CS-3 will be launched in 1988 when the CS-2 is scheduled to expire. The project mission of the CS-3 is as follows:

- to continue and expand the service of the CS-2;
- to offer particular telecommunication services (for example, offering satellite telecommunication services for broadcasting and digital telecommunication services); and,
- to design the communication satellites and acquire the know-how of manufacturing them.

In order to meet these mission objectives, and improve efficiency, the CS-3 is to be given increased longevity and larger capacity than the CS-2. The satellite will be launched by the Japanese H-I vehicle; its weight is approximately 550 kg, and its life will be 7 years. This satellite will provide 2 transponders at 6/4 GHz and 10 transponders at 30/20 GHz.

3. OTHER SATELLITE PROJECTS

Using this opportunity, we would like to introduce the Japanese broadcasting satellites which have direct relation with the Ministry of Posts and Telecommunications, and aeronautical-maritime applications. Our country is well suited for the application of broadcast satellites because its domain is not so wide, and its terrain is mountainous. From 1978 to 1980, experiments had been done for supporting that the general public could receive television by means of parabolic antennas whose diameter was smaller than 1m. This could be accomplished using limited transmitting power because it is concentrated upon the small land area. Satellites possessing almost the same specifications as those used for these experiments will be launched up by the Japanese N-II launch vehicles in February 1984. These satellites are called BS-2. Since these satellites are limited to 350 kg "in orbit" weight for stationary satellites, 2 channels of television broadcasting services will be accomplished using 12 GHz/100w of transmission power.

Furthermore, tests for the second generation BS-3 broadcasting satellites have already been started in order that they can be launched around 1989.

The broadcasting satellites are the means suitable not only for television broadcasting, but also for high quality sound broadcasting using pulse code modulation (PCM) and high definition television broadcasting. If further technical development is

Table 2 Main features of spacecraft (CS-2)

Physical Configuration and dimensions Diameter Height	Cylindrical spacecraft, entire spacecraft spinning with despun communication antenna 218 cm 329 cm (including despun antenna) 204 cm (solar array)
Weight	670 kg (at launch) 350 kg (in orbit)
Stabilization	Spin stabilization / 90±9 r.p.m.
Communication subsystem Antenna Transponders	Mechanical despun antenna with shaped beam horn-reflector 6/4 GHz (C-band) : 2 channels 30/20 GHz (K-band) : 6 channels
TT&C subsystem Antenna TT&C equipments	S-band : Omni-directional C-band : Communication antenna (shared use) NASA STDN compatible S-band transponders, C-band/S-band converter, telemetry encoder and command decoder
Electrical power sub-system Solar array Batteries	480 W at BOL (summer/solstice) 410 W at EOL (summer/solstice) 12 AH x 2
Pointing accuracy of communication antenna	Within ±0.3 deg.
Thermal control	Passive system, augmented by heaters
Reaction control	Hydrazine monopropellant system
Apogee kick motor	Thiokol STAR-27
Orbit position CS-2a CS-2b	132 deg. East longitude 136 deg. East longitude
Station keeping	Latitude : Within ±0.1 deg. Longitude : Within ±0.1 deg.
Life	5 years (design goal)
Launch vehicle	Japanese N-II vehicle

accomplished, and if problems for adjusting between fee-charging broadcasting system and other existing broadcasting systems could be solved, it might hasten the time of using the broadcasting satellites for the purpose of performing such a new broadcasting service.

Now, we would like to touch on the aeronautical maritime engineering satellites. This satellite was formally called ETS-V. Our country is surrounded with the sea, and a multitude of small ships numbering over 70,000 navigate the peripheral sea area. Technical developments involving mobile communication satellites would be attractive in the future offering economical telecommunication services to these ships. Further, mobile telecommunication means could also serve aircrafts, automobiles, and so forth. The ETS-V is being tested for launch by means of the H-I launch vehicle in 1987.

Fighting "Isolation Fever": An Inexpensive Voice-Data Satellite Service for Remote Locations

E. A. Piekaar
New Business Development Administrator
British Columbian Telephone Company

Economies based on the extraction of resources are often characterized by isolated work sites. Forestry, mining, and some construction activities occasionally occur in distant and scattered locations where land-based telephone service is not yet in place, or perhaps never will be a practical option. Vast spaces, rugged terrain, and isolated settlement patterns present obvious problems to the establishment and maintenance of effective telecommunications links. This is as true in the United States and Canada as it is in many parts of the developing world.

When remote sites have to communicate with the outside world, they often use high frequency and very high frequency radio-telephone. But there are some drawbacks to this system, including occasional unreliability in mountainous terrain, lack of privacy, low transmission quality, and difficulty in transmitting data.

Now there is a more efficient way of communicating voice and data between a remote site, which is not attached to the telephone network, and the rest of the world: or at least those remote areas covered by satellite footprints. The solution is the Single Channel Per Carrier Earth Station system, a satellite thin-route service which provides remote areas with access to the switched telephone network via communications satellites. In this SCPC system, calls are looped from the subscriber's phone in the isolated area, bounced off a satellite via a portable earth station, and channelled through a central control station into the worldwide telephone network.

The solution was developed in British Columbia, Canada's rugged west-coast province, by the British Columbia Telephone Company's manufacturing and research and development subsidiaries, AEL Microtel Limited and Microtel Pacific Research Limited. The system connects the farthest corner of B.C. with a central telephone switch in downtown Vancouver.

It is no coincidence that the SCPC Earth Station originated in British Columbia. The province consists of extensive, yet remote and isolated, resource operations, mostly in the mining and forest-product industries. There is also considerable energy-resource and construction activity. For example, mining companies and the provincial government are currently engaged in the development of extensive coal resources in the north-east corner of the province, which requires the creation of town sites and transportation links.

Above all, British Columbia is a highly mountainous and vast region.

Nor was it a coincidence that the SCPC Earth Station was originated by AEL Microtel and Microtel Pacific Research. The latter is the largest research and development firm in western Canada, involved in, among other projects, the designing, testing and packaging of integrated circuitry. AEL Microtel, the largest secondary manufacturing firm in British Columbia, is a significant producer for world-wide markets of electronic equipment, including transmission and supervisory and control technology.

The SCPC thin-route service boasts a number of space-age features. It is relatively light-weight and compact, versatile, reliable, and low in cost (compared to existing satellite systems). Subscribers in an isolated area can have a Vancouver number, receive a Vancouver dial tone, get access to all telephone services available, transmit data, and receive broadcast services.

Yet, it is somewhat surprising how simple the equipment is, both in terms of appearance and operation. Basically, there are two components--a dish-style antenna six to ten feet in diameter, and the radio frequency components, partly kept indoors and partly outdoors, which are no larger than components in the average home stereo system. Advanced microelectronic chips form an essential part of the hardware. No specialized electronic skills are required to operate the equipment, which is delivered on-site by a pick-up truck.

Technically, the 14/12 GHz Single Channel Per Carrier system is configured as a star network to extend the subscriber services available at a central site to any location within the appropriate satellite footprint. High quality voice transmission is provided using 32 kb/s digital encoding and QPSK modulation. Demand Assignment Multiple Access (DAMA) reduces satellite transponder bandwidth requirements. This reduces costs associated with the system by increasing the use of channels on an efficient basis. More locations can be served by the existing RF channel bandwidth.

The system is integrated with the voice network on a subscriber loop basis, greatly simplifying the role of the central control station. The station, located in downtown Vancouver, provides interfaces to the voice and data networks for up to 1,000 subscribers, and is equipped with an elaborate maintenance, testing and alarm reporting system.

After AEL Microtel developed the system, it was put to work in a field evaluation during the summer of 1982. A portion of an experimental 14/12 GHz RF channel on Canada's Anik B communications satellite was used. British Columbia Telephone Company shifted the SCPC system to various sites throughout the province during a two-month period. Among the remote-location users were forest-product companies, mining companies, the provincial government, and the provincial hydroelectric utility. The sites ranged from the mushrooming coal-mine development in the northeast, Tumbler Ridge, to the isolated Queen Charlotte Islands, just south of the Alaska panhandle.

The field evaluation considered a number of factors, such as the portability of the dish antenna. B. C. Telephone personnel were also interested in required installation times, the effect of climate and various terrain on signal quality, the durability and reliability of the equipment when faced with frequent transportation over bumpy roads and rough airplane rides, the level of customer satisfaction, and billing procedures.

After the two-month field evaluation, it was obvious to AEL Microtel and B. C. Telephone personnel that the test had been extremely successful. Even more impressed were the participants at the various remote locations. Such comments as "remarkable," "impressive transmission," and "excellent reception and quality" were commonly voiced by the users. As one impressed participant from a forest-products company declared, "Everyone who used the phone was very pleased with it," especially with the ability to access a dial tone in Vancouver, many hundreds of miles to the south. A further field evaluation was held in the autumn of 1982, with a view towards stimulating future sales.

Given the success of the SCPC Earth Station, B. C. Telephone will be discussing terms with potential customers of the service. Interest is already building. The telephone company expects to begin the service by the middle of 1983, and has placed an initial order with AEL Microtel to meet requirements for 25 locations in 1983. In 1984, B. C. Telephone expects to offer up to 12 channels per unit, and supply service to up to another 150 locations. Among the interested customers will be the phone company's network operations, which may use the SCPC system to bolster its operational service capabilities.

Another element of the remote service was laid into place in November 1982, when Telesat Canada launched its latest domestic communications satellite via the space shuttle, the Anik C-3. B. C. Telephone will be utilizing a portion of a 14/12 GHz RF Channel on this Anik satellite.

Meanwhile AEL Microtel has been instituting further refinements to the system. The size of the electronic hardware is being reduced, the data capability is being enhanced, and multichannel capacity is being developed. Almost every area of Microtel Pacific Research has been engaged, from

digital transmission to supervisory and control. Many millions of dollars are being invested by AEL Microtel to bring the SCPC system into mass production in the first quarter of 1983. Most AEL Microtel factories, which stretch from Ontario to British Columbia, will be involved in the manufacturing, with final assembly and testing taking place in the Vancouver area.

In Canada, the federal Department of Communications has played a constructive role in recent years in promoting the development of various telecommunications advancements. In November 1982, the department recognized the importance of the SCPC Earth Station for resource-based industries in northern and western Canada by awarding a contract valued at \$1.4 million to Microtel Pacific Research. Microtel's technical training facility, TeleTraining, is currently preparing engineering courses relevant to the SCPC system, which will be offered in 1983.

While most communications from remote stations will be in a voice mode, the demand for data communications is increasing. The B. C. Telephone system will accommodate up to 0.6 kilobits per second of data. AEL Microtel has incorporated a very accurate half-rate forward error correction, which allows effective data transmission. Canada's national Datapac system, a computer communications network operated by the country's telephone companies, will provide packet switching of data through the Earth Station. Thus the office of the future can easily be established on some lonely, windswept coastal island. The SCPC link will clearly be a benefit to resource companies, construction sites, and the government.

Remote terminals will also be capable of receiving broadcast services such as television and radio, and radio distribution, allowing the system to be a complete communications link. Another feature, which is being developed, is the use of the satellite system for trunking between a small central office and the network. Moreover, PBX tie-ins can be expected.

The SCPC Earth Station system is important and unique for a number of reasons. For one thing, space-age satellite and microchip technology has been successfully harnessed to decrease the difficulties inherent in communicating with isolated or poorly served locations in North American and developing countries, as well as western and northern Canada. The system should thus be a great advantage to companies involved in resource, construction, or other activities in places not served by the terrestrial telephone system. The SCPC system will also be invaluable in emergency cases of malfunctions by terrestrial links, especially as the service is highly portable and versatile. It will also combat the loneliness and isolation fever of employees residing in remote areas.

Another important factor behind the service is the manner in which it was developed. It was the pro-

duct of the marriage between a telephone operating company, a manufacturing firm, and a diversified research and development operation. The productive relationship between the phone company and its high-technology subsidiaries will be enhanced as AEL Microtel develops its multi-million dollar microelectronic chip centre. Some of the resulting silicon devices will be incorporated into further refinements of communications technology.

Requests for information on the SCPC system have been received from numerous organizations in North America and around the world. At the present time AEL Microtel has submitted tenders to one Canadian telephone company aside from B. C. Telephone, and is negotiating with an international financial organization which is considering the satellite system for its own requirements.

Finally, the service represents a significant opportunity for B. C. Telephone as an operating carrier. A low usage-sensitive fee plus a nominal access charge make the service inexpensive for customers, and quite attractive, while extending data and business communication links to new areas will provide an important and growing source of revenue for the telephone company.

TECHNICAL APPENDIX

THE SYSTEM

Service requirements of the end users have dictated that the system be designed to meet the following objectives: i) Low-cost, transportable and easily maintained remote terminals, ii) high-quality, reliable and private voice and data service, iii) single-channel and multi-channel remote terminals, iv) full integration into the voice and data networks, v) pre-assigned or demand-assigned modes of operation, vi) built-in billing and monitoring facilities.

To accomplish these objectives, the system has been conceptualized as a thin-route single-channel per carrier (SCPC) system operating in the 14/12 GHz band and configured as a Star network with a large central control station (CCS).

For this application the SCPC approach is favoured over other techniques such as time division multiple access (TDMA) as it is well suited to serving a large number of locations with small channel requirements. The majority of remote locations will require only one channel.

The 14/12 GHz frequency band offers the advantage of relatively small antenna sizes which contributes to the low cost and transportability of the remote terminal. A Star configuration with a large CCS has been chosen so that the size and power requirements for remote terminals can be kept to a minimum. Other important features of the system are a usage sensitive billing method and an active maintenance strategy using built-in test facilities at the CCS.

CENTRAL CONTROL STATION (CCS)

The central control station provides interfaces to the voice and data networks for up to 1,000 subscribers. Subscriber loops from the central office switch are connected to the CCS through voice network interface units which continuously monitor the VF (voice frequency), DC and AC (ringing) conditions of the loops. Echo cancellers are incorporated to provide enhanced subjective circuit performance. Subscribers requiring data services are interconnected with the data network through an RS232C interface.

Operation of the entire satellite network, collection of status and alarm information is controlled by a network interface processor. The DAMA controller allows frequency allocations through the transponder.

The billing equipment receives network interface status information and processes it to provide a per call data package that can be integrated with the operating company's billing system.

An elaborate maintenance, testing and alarm reporting system is equipped in the CCS. Test units are provided to test integrity of each channel. An automatic testing routine performs a loopback test on each remote terminal periodically at quiet times. Alarm information on a pre-module basis is provided by a processor-controlled alarm system. In addition, to maximize system availability, each active unit affecting more than one shelf is protected by redundancy.

REMOTE TERMINAL

The remote terminal consists of three basic assemblies: indoor equipment, outdoor equipment, and interfacility link. The equipment is compact, durable, packaged to be easily transported, and is designed to withstand harsh environmental conditions.

Indoor Equipment

The remote terminal is interfaced with the subscriber terminal apparatus through a VF Interface unit or Data Interface unit, or both with a voice/data switch for shared use on an alternate basis. A continuously variable slope delta modulation is used to encode/decode the VF signals onto a 32 kb/s digital stream. QPSK modulation is used and the radio frequency carrier is only activated when the audio signals are present. Other modules forming part of the indoor equipment include AGC and AFC controls, a pilot tone receiver which processes the system pilots to obtain the reference distributed by the CCS; and the timing and frequency generator which supplies clock signals and synthesizes the reference frequency used in the outdoor unit.

Outdoor Equipment

The outdoor equipment consists of an antenna and an associated electronics package. Antennas range in size from 1.8 to 4.5 m.

The outdoor electronics contains a Frequency Converter module which consists of a single conversion up-converter and the first stage of a dual-conversion down-converter, equipped with a low-noise GaAs FET front end.

The transmit power amplifier is a solid-state, 1-watt device except in the case of multi-channel terminals which are equipped with TWT amplifiers.

Telephones for a Rural People - Vanuatu

Roy G. Spratt,
Roy Spratt and Associates,
Canberra, Australia.

William A. Southwood,
Ove Arup and Partners,
Sydney, Australia.

1. Abstract

A terrestrial system of low capacity high quality radio circuits has been installed to link the two main urban centres, and also to provide service to the rural populations scattered throughout the archipelago. The system is described, and available information on its acceptance by the population analysed.

2. Introduction

The organisers of this Conference had difficulty in deciding whether this paper should be in a policy or technical session. They decided on technical and Mr. Bill Southwood has joined me, to present the technical section.

But this dilemma highlights the problems of all telecommunication administrations - policy, particularly in the short to medium term can only be determined in the light of the state of the art, and the most elegant technical solutions are of limited use if not in line with policy objectives.

The Postal Department of the Condominium of New Hebrides were acutely aware of the necessity of developing the telephone trunk network from at least 1970. At that time there were only two H.F. channels manually switched between the two main centres of population, Port Vila and Luganville, both of which had automatic exchanges.

The approximate population of the Condominium at that time was 90,000 of which some 10,000 resided in Port Vila, 3,500 in Luganville and the rest in villages ranging from a couple of houses to several hundred people. Currently the population exceeds 120,000.

The country is an archipelago of some 80 islands spread over 850 kilometres. The telecommunication requirements outside the two urban centres were met by a conglomeration of private, public and government low grade radio networks mostly H.F. developed because of needs of commerce, shipping, aviation and public requirements, needing a large operating effort to produce a poor grade of communications facilities.

Australia, with its increasing development assistance emphasis on the South Pacific region sent a Program Planning Mission to Vila in 1976, and its assistance was sought in the improvement of the telecommunications trunk network, in sound broadcasting and aeronautical navigation aids.

The first telecommunications priority of the Condominium Post Office was the upgrading of the spine link between Vila and Luganville. Others were acceptable quality spine circuits south from Vila, and a spur route north from Luganville.

3. Organisation

Previous activities in these sub-disciplines in Australia's development assistance had been supported by the Australian Post Office and its successor the Australian Telecommunications Commission (Telecom Australia).

In line with Australian Government policy in 1976, this support was no longer available. The consulting industry in these fields in Australia was still in its infancy, and the Australian Development Assistance Bureau (A.D.A.B.), mindful that most of the requisite skills were employed by manufacturers, sought in February 1977 from the whole private sector, proposals to handle the many sub-disciplines involved in telecommunications, sound broadcasting and aeronautical navigation aids.

A group headed by Ove Arup and Partners was selected in April and their brief was subsequently extended to manage the implementation of the projects.

To meet the requirements of the New Hebrides Central Planning Office as well as A.D.A.B. for information on which to

assess the costs of the inclusion of such a project in the Australian program, by providing information on projected demand, appropriate tariffs and the like, W.D. Scott and Co. Pty. Ltd. were briefed separately to investigate these aspects. (Ref. 1)

As Project Managers the Ove Arup group was responsible for the design (Ref. 2), preparation of tender specifications, the calling of tenders for the buildings, towers, power plant and radio equipment, the recommendations to the Department of Foreign Affairs Tender Board for the letting of contracts, the supervision of the contractors and the acceptance of material and work. They were also responsible for the recommending of the balance between local and overseas inputs, and the training of local staff to ensure that the completed installations would be able to operate satisfactorily.

After detailed consultation between the two organisations and the Governments of the New Hebrides and Australia, the policy was adopted to plan the system so that an automatic telephone service could be provided to each village of a hundred or more people, and to each institution such as dispensaries, schools and to businesses. The final reports were submitted in November 1978.

4. Demand

The following section was prepared by Dr. Vern Harvey then of W.D. Scott and Co. Pty. Ltd. covering the highlights of the demand study and report:

'The patterns of growth for telecommunications in the New Hebrides were hard to predict and were influenced by many different factors: the stage of economic and social development of the population, mobility within the society and the cultural and community structures of the population.

In making our demand estimates there was a shortage of up to date reliable statistics and demographic data. We used what was commonly available plus traffic figures based on actual current usage collected either by ourselves during our visit or supplied at our request by the Condominium Radio Engineer or Postmaster.

People in the New Hebrides communicated in a number of ways:

telephone	) forms
telegram	)
private radio	) of
tele-radio	)
service messages by	) telecommunications
public radio	)

messages carried by another person
letter
face-to-face.

In many areas people did not have ready access to any form of telecommunication facility.

Usage of the existing telecommunication forms was estimated from the available data but we also tried to measure the other forms of communication.

For example, very little information was available concerning the number of letters forwarded from one area to another. So we undertook a sample survey at Vila Post Office.

In the case of service messages broadcast by the Administration we were provided with an estimate of approximately 40 per day for the British Broadcasting Service.

Our task was to estimate a demand which did not and could not exist at the time we examined the problem.

One approach to such a problem is to examine situations in similar circumstances and other places and see what happened in these cases. Because we could not find adequate models for this approach we decided to adopt a more basic approach to the measurement problem. The key to what we believe was the success of our approach was the small size of the market. By disaggregating the market it was possible to be precise about the number of potential subscribers to a degree which would not be possible with a larger population or a more sophisticated economy.

In turn we were able also to use the other approaches as checks to apply after our own approach had produced its results.

A possible pricing policy was a complicating factor. Firstly, there was an organisational structure in which the Post Office and the Radio Department were separate Government Departments, with no independent status. In addition, the existing service on the major route between Luganville and Vila was at

capacity and the relationship between pricing policy and usage was very obscure.

After estimating expenditure associated with our demand estimates we calculated revenue from the system over 15 years using various call and rental charges and using different inflation rates for expenditure. Provision was made for sinking fund payments and a series of total net revenue streams was derived.

The internal rate of return was determined for each of these net revenues to be used as a guide in the final investment decision'.

The Harvey estimates were that along the main spine route between Isangel in the south via Vila to Luganville in the north the demand for telephone service would increase by 51% from 1,302 to 1,966 subscribers. Along the spur routes the increase was five-fold from 43 to 212 subscribers. (Outside the two urban areas, "existing subscribers" encompasses all types of radio terminals) Traffic estimates showed a similar explosive increase.

Growth after the initial expansion was more problematic. The report notes that the estimate of subscriber growth is subjective and "tends to be more related to our own estimates of the future development of particular parts of the country and possible projects which may be undertaken".

Nonetheless, the demand and tariff study confirmed that the type of technology being considered and the location of the routes would provide coverage to over 95% of Vanuatu's population, and that a 60 channel trunk system should be adequate over the main spine route for 15 years.

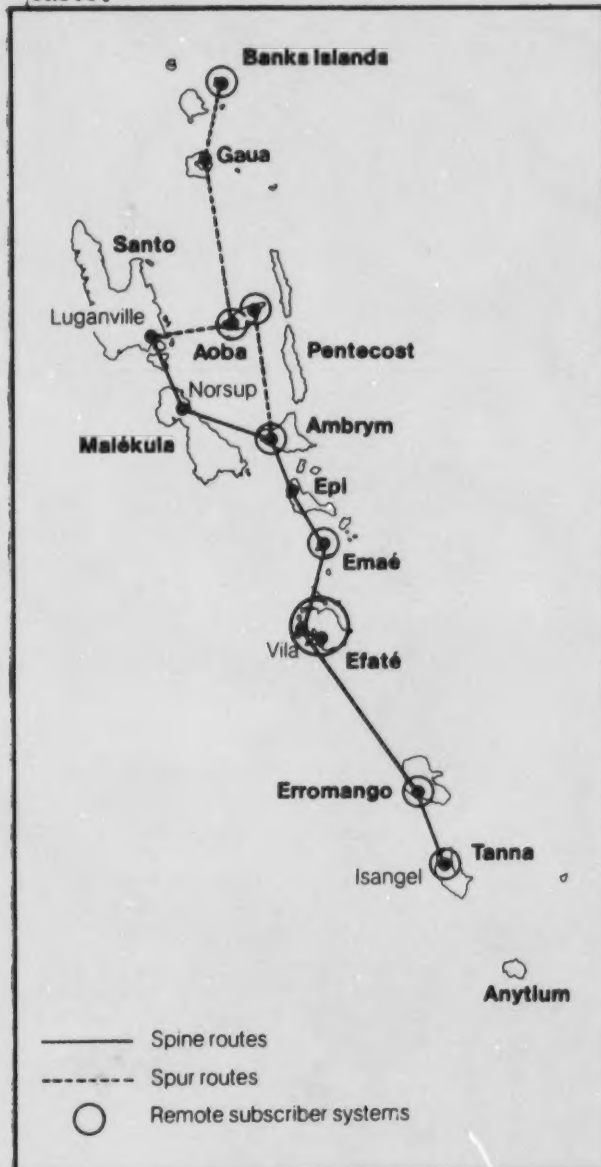
5. System Planning

Given the very small number of existing sites and the use of mainly high frequency services around the islands, we started with an almost clean slate. There was a considerable amount of knowledge on the country: many sites had been investigated on foot, accurate maps were available for most of the islands and logistics were well understood.

On the other hand, very little data existed on propagation in Vanuatu, although single channel V.H.F. links had

been installed on Efate and from Vila to Santo with an intermediate repeater on Malekula.

From this rather mixed data base a system was to be planned. This section covers the process by which 60/120 channel analogue bearers working in the 400 and 900 MHz bands were chosen for the line of sight routes, and 150 MHz analogue concentrator systems for the subscriber bases.



VANUATU - Formerly NEW HEBRIDES

5.1 The Integrated Approach

Although the original brief concentrated on the Vila-Luganville connection, a system design integrating the requirements of the main spine routes with servicing remote radio subscribers had overwhelming advantages, with spur routes to bases to reach subscribers beyond the spine routes. The main routes would thus carry traffic between the major centres of Vila and Luganville, the minor centres of Norsup and Isangel, and a very substantial amount of traffic originating and terminating at remote subscribers.

The locations of the two established and two proposed exchanges were known. Deciding on where to place subscriber bases in order to cover the maximum population and at the same time use sites which were on the trunk route involved careful evaluation of dozens of possible paths and sites.

5.2 System Capacity and Technology

The demand study had identified a fifteen year need for up to 47 channels on the north spine route between Vila and Luganville. The need to provide remote service resulted in the selection of eight sites for remote subscribers, four of them on the north and south spine routes, the other four being fed by spur route bearers.

Feeding both north and south routes into Vila over one bearer, it was clear that more than 60 channels could be required within the plan period, so it was decided to use a 120 channel bearer in the 900 MHz band on the single hop from Vila to Mele Lama. The remainder of the bearers both spine and spur routes were to be 400 MHz bearers with a maximum capacity of 72 channels.

Of the nine repeaters required in the system design, five would require channels to be dropped off for remote radio subscriber bases. Consequently the planning of efficient and economical drop and insert multiplex was critical to the system design.

Early in the planning stage the possibility of using digital transmission radio was considered and rejected. Suitable digital equipment was not available in the late 1970's and, even today very few manufacturers have seriously addressed the problem of dropping and inserting channels along a digital path.

5.3 Site Selection

One obvious method of serving the islands was to place a repeater and subscriber base on the tallest mountain of each conveniently located island. This would have ensured the maximum distance for each hop, minimum cost of equipment and the greatest coverage for the remote subscriber system. It would also have required helicopters which, as was made clear early in the planning stage, would not be available in Vanuatu either during construction or for operation and maintenance. Another approach was required.

Site selection had therefore to consider the needs of conventional surface access. The conflicting criteria which had to be covered included:

- Adequate close in clearance on the line of sight (L.O.S.) routes
- Adequate Fresnel zone clearance on the L.O.S. paths
- Maximum coverage of densely populated rural areas for V.H.F. subscribers
- Accessibility to a landing place for heavy materials
- Accessibility to an airstrip
- A level piece of land suitable for the repeater
- Practicability of building a road for access during construction
- The road to be usable for system operation and maintenance.

This last point was the subject of some considerable discussion. It was initially considered by the authorities in New Hebrides that all maintenance access would be by foot. As on a number of the remoter islands there are no 4-wheeled drive vehicles let alone a bulldozer, this approach was understandable. Nonetheless where possible roads were designed to be maintainable.

As the site selection proceeded it became clear that compromises would have to be made. In one illustrative instance the original plan to use Mount Bernier, one of the highest peaks on Efate, had to be abandoned. The preferred site on the next island to the north, Emae, could not be reached by any constructable road nor could adequate land be found.

Moving to an adjacent slope on Emae meant that line of sight from Bernier was obstructed to an unacceptable extent. The lower and more accessible site chosen on Efate then had ramifications for the south spine route where the Fresnel zone clearances were already less than would have been used in a conventional system.

These trade offs between some quantifiable and some rather intangible factors continued right up until the time of placing the final equipment contracts and required a full knowledge of all aspects of the disciplines involved in telecommunications design and construction.

5.4 Performance Prediction

The geography of Vanuatu meant that many routes would incorporate long over water paths. Site limitations referred to in the previous section meant that in many cases path losses included a significant element of diffraction loss.

Use of the 400 MHz band offered the most economic means of achieving the 60 channel capacity required. Whilst frequency diversity involved two transmitters in continuous service it was decided that the additional power consumption would be preferable to the very tall towers with increases in the cost of site and civil works as well as feeder losses that would have been required to achieve adequate diversity spacing.

Although the original feasibility study envisaged unduplicated spur routes, it was later decided to provide hot standby configuration. Whilst this gave no diversity improvement the consequences for maintenance were considerable.

During the feasibility study propagation tests were carried out at 900 MHz on a hop of approximately 90 km. This path did not fully meet Fresnel zone clearance criteria for line of sight, and a median obstruction loss of 7db was observed.

Climatic records showed that maximum fading could be expected in September and October, the least favourable months for atmospheric gradient. Fades of up to 10db were observed during two relatively short periods at this time of year.

Because of restrictions in the ITU Radio Regulations for use of the band 403-470 MHz it was necessary to use diversity frequency spacings of less than 3%. Even with this spacing, frequency diversity has been found to be effective on those relatively short over water paths where reflections cause severe fading usually late in the morning.

Performance of the longest and most severely obstructed path, 154 km between Mele Lama and Fedmogkoum exceeded predictions, as did most of the paths. In a number of cases this was due to positive reinforcement from reflected signal; in others it was attributable to better performance of all components, antennas, feeders, branching filters and radio equipment, than had been allowed for in the original design.

Because of the geography of the country, it was not possible to specify a feasible system which would fully meet the criteria of CCIR recommendation 395-1, although performance of the links was predicted against those criteria. Engineering of the system was to provide a link that was within 3db of the CCIR recommendations on the north spine, and within 4db on the south spine. In both cases the 47,500 pw percentage was exceeded.

During commissioning testing all of the links performed in excess of predictions, the north spine in fact demonstrated a median performance better than CCITT. The south spine was within 1db of the same figure. In both cases the links were below the 7,500 pw allowed on a hypothetical path of 2,500 km.

Results on some typical paths are shown in the table below:

Route	Signal/Noise Rec 395-1	dBmOp. Median Measured
Vila-Luganville (north spine link)	59.3	59.5
Luganville-Mota Lava (spur link)	60.2	55.0
Mele Lama-Fedmogkoum (longest path)	61.8	70.0

6. Realisation

Demand studies and technical feasibility reports have one order of difficulty. To make a project happen involves a much higher order. This next section covers the way the ideas outlined in the feasibility studies were brought into practice.

6.1 Project Management

There had been an integrated design approach to the needs. Clearly the same kind of integration was required to implement the design. The Australian Government in providing the funding required that the project was carried out efficiently.

The Ove Arup group managing the implementation of the project were:

Ove Arup & Partners	Civil Structural and Telecommunications Engineers
Lincone Scott	Electrical Engineers
Noel Medlin	Radio Propagation Engineer.

6.2 Sites and Access Roads

Although the route had been tentatively selected at the feasibility stage, many of the sites were so inaccessible they had not been visited. The first requirement was therefore to reach each site, cut down enough vegetation to enable clear lines of sight to be established and confirm that there was both sufficient land and a feasible road route. The Radio, Lands and Public Works Departments assisted the project managers in this, as in later phases of the site and structural works.

As these investigations proceeded, over a period of 18 months a number of sites were changed. The Efae and Emae sites have already been mentioned. Land rights problems on Tanna required a change of site in the south.

For each location a site was surveyed with a centre line for an access road. The site clearing and access road building was co-ordinated closely with the Public Works Department so that roads were provided concurrently with other road building programmes.

6.3 Buildings

Because of the difficulties of access and the problems of finding sufficient skilled tradesmen in Vanuatu to carry out a large building program on such remote sites, it was decided to use pre-fabricated buildings for all repeater stations. After tenders were called a design was selected consisting of a sandwich construction with an outer asbestos cement panel and a polyurethane core erected on a cast concrete slab. The buildings like all other structures were designed to withstand winds of 220 km per hour, and the design incorporated continuous tension members between the floor slab and the roof to ensure the building's security.

The buildings have three main compartments; an equipment room, a battery room and a diesel generating room.

They had to allow adequate ventilation for equipment and prevent water entry on mountain tops in the cyclonic conditions in Vanuatu. Modifications are being made to improve the resistance to the entry of upwards driving rain.

6.4 Towers

The towers were 32 m high except for two stations where 15 m was adequate.

The foundation designs had to cope with soil conditions ranging from hard coral to volcanic ash. The designs utilised passive soil resistance to resist uplift.

The foundations for the towers and buildings were cast by the Public Works Department well in advance of erection, using templates supplied by the tower and building contractors.

The towers were designed to carry up to four 4 metre diameter grid antennas at the top.

6.5 Power Supply

Provision of adequate power at the remote repeaters proved one of the most challenging aspects of the whole project. Reliance on diesels would have meant not only an extremely high operating cost to transport fuel to the repeaters but also foreign exchange for it. Possible power sources investigated included thermoelectric generators, solar powered turbines, wind generators and diesels. It was concluded that solar power and storage batteries with diesel back up

would be the most economical and technically efficient solution.

Nickel cadmium batteries have the advantage that they are relatively immune to damage from excessive discharge. Against this were assessments that the nickel cadmium battery does not accept charge at the low rates often experienced from solar panels and that they tended to lose capacity after a prolonged series of discharge cycles.

Experience in Australia indicated that, with their very low self discharge rate, lead acid batteries with pure lead plates would be most suitable for solar power applications.

The peak wattage of the solar cells provided was chosen at five times the average station load. With no insolation figures available for many of the sites, this was a compromise.

After discussion with the user authorities, battery autonomy was set at 90 hours, but after six months of operation, both normal and with alerts due to equipment malfunctions, it is clear that this should be raised to 140 hours.

A control cubicle with voltage sensing relays was provided to control the 4 KVA diesel alternators automatically if insolation was insufficient to keep the battery voltage at an appropriate figure. The control cubicle also fed to the maintenance control centre of Vila information on the state of the batteries, alarm conditions and diesel operation. Supervisory control was provided to remotely reset alarms, and start and stop the diesel.

6.6 Structures, Towers, Antennas and Feeders

The tower contract was let to an Australian manufacturer.

Logistics of taking tower steelwork and building panels to sites were co-ordinated between the project manager, Radio Department and Department of Public Works. The tower contractor's program of tower erection was duly completed on schedule.

Antennas and feeders were manufactured in Australia, and were erected by the supplier and Radio Department rigging staff.

Finials on towers, an earth network and close attention to bonding of all

equipment on each site were necessary to protect the repeaters against lightning.

6.7 Line of Sight Radio and Supervisory System

During the period of site selection and clearing, specifications were written for all of the radio equipment to be provided. The specification was split into packages to achieve the maximum benefits from competitive world wide tendering. The largest of these covered the line of sight radio and supervisory systems.

After discussion of the draft tender documents with the Radio and Telephone Departments in New Hebrides, and further investigation of some of the sites and routes that appeared difficult, the specification was agreed and tenders were called at the end of 1979. After a three month tendering period and assessment, a contract was awarded to NEC Australia Limited late in 1980.

The line of sight radio was provided within the 403-470 MHz band. Frequency diversity and hot standby configurations were used, with transmitter powers 3 and 10 watts and receiver noise figures of 3 and 6db. These parameters, antenna diameters and system loading were optimised to give the most cost effective solution for the whole system.

The extensive supervisory system provided 32 alarm or status indications from each site. Up to 8 commands could be sent from Vila to each station. Engineering order wire circuits were provided at each station.

6.8 Voice, Telegraph and Program Multiplex

Specification of the multiplex had to allow for the very high number of drop and insert channels called for in this system. The alternatives of using the conventional channel, group and super group multiplex or direct to line (D.T.L.) multiplex were allowed for.

Given the demand for telex subscribers in Luganville, and public telegraph traffic to the provincial headquarters of Norsup and Isangel, voice frequency telegraph equipment was called for in each of these locations.

A program channel was also provided between Vila and Luganville for Radio Vanuatu, studios and transmitters for which had been provided by Australian aid (and by the same project management team) as a separate project.

Most tenderers offered conventional multiplex with extremely high reliability low power consumption and small space requirements.

6.9 Remote Subscriber Systems

Remote subscribers were specified as a separate package. Of the two different systems offered, that of NEC was selected. The remote subscriber system had to be low in power consumption, provide the same facilities to a remote telephone that would be enjoyed by an urban telephone subscriber, be highly reliable and offer the maximum possible coverage. The R.S.S. system chosen had been used elsewhere in the Pacific (Papua New Guinea being one of the first users) and in Australia. Analogue V.H.F. radio operating in the 150-170 MHz band provided the bearer, and a solid state concentrator was provided at each exchange. Initially equipped for two R.F. channels and up to eight subscribers the system provides for an ultimate capacity of eight R.F. channels which can support up to 96 subscribers. The grade of service will depend on the traffic from each subscriber, and estimation of this quantity is of critical importance, not only for the service to subscribers but on the dimensioning of the power supplies for each remote subscriber base.

The bases were provided with omni-directional antennas and subscriber sets provided with a range of antennas of different gains to be used depending on the path loss. The concentrator system enables subscribers to send and receive calls to the main exchange, and for subscriber to subscriber calls to take place. In this project eight bases and fifty outstations were provided. Outstations were provided with a conventional telephone instrument for either desk, wall or outdoor mounting.

7. Training, Operation and Maintenance

Participation by staff of all government departments was encouraged at all stages of the project resulting in a familiarity with the systems as they were installed which could not have been achieved in any other way. This was most significant for the ni-Vanuatu staff of the Radio Department who would be responsible for maintenance of the system.

This practical on the job training was supplemented by a series of formal classroom courses, held in Vila during installation. One of the installation staff stayed on after completion of the contract, to assist during the period in

which the system commenced full commercial operation.

All sites were provided with documentation including handbooks and drawings, factory and commissioning test data. Test cords, extender cards and consumable spares such as fuses and lamps were also provided. Maintenance bases at Vila and Luganville were equipped with all the test equipment necessary for preventive and corrective maintenance of the systems, and for installation of remote subscribers.

Spare modules were provided for all radio and multiplex equipment, the philosophy being module replacement and factory repair.

8. Current Position

The spine link Vila-Luganville was opened for traffic at the end of 1981, and fifty remote subscribers' sets have been progressively installed from February 1982. These have been in Post Offices, hospitals, dispensaries, local councils and villages. The calling rates from the R.S.S. have been very high - the highest being from one Post Office which recorded 2,467 calls in the September 1982 quarter. The twenty eight sets connected for the whole of the September quarter generated 21,982 outgoing metered calls, an average of 785. In the previous quarter these same subscribers averaged 75 minutes of Vila-Luganville calls.

The highest calling rate sets have been routed direct to Vila clear of concentrators. Queues of waiting callers are not unusual, and there are some problems with the public use of sets in council offices, dispensaries and schools, interfering with normal work.

The Vila-Luganville circuits were manually switched at Vila until October 1982 when they were cut over to S.T.D. Traffic counts just before the cut over showed over 3 erlangs in the busy hours.

There are some distortions in the traffic handling in that the R.S.S. are nearly all terminated on Vila exchange whereas there is a community of interest between the northern islands and Luganville. But there is also a community of interest with Vila, and the net effect on Vila-Luganville junctions is probably small.

The administration is moving towards a full revision of their tariff structures but it cannot be fully implemented until

the new small exchanges envisaged in 1977 are established at Norsup and Isangel, and Luganville upgraded to accept R.S.S. subscribers.

International calls, are but a small proportion of the traffic from the R.S.S. but a docket check of forty three subscribers covering seven days in September showed ten successful international calls and two unsuccessful attempts (called party unavailable).

The installation charge (as for urban land line services) is 12,500 VT and the annual rental 15,000 VT (10,000 VT for urban phone). An additional rental of 3,000 VT applies if a solar panel and battery installation is required. (1 VT ~~2~~ 1 cent U.S.)

Current call charges are 10 VT for a local metered call, 90 VT for a manually connected 3 minute Vila-Luganville call and 10 VT for 24 secs on an S.T.D. Vila-Luganville call.

Charges to non subscribers were recommended at not less than 90 VT per 3 minute call, but charges of 180 VT have been reported.

Further there is an unsolicited pent up demand for 350 more remote subscriber services. All this in a community with a limited cash economy in the rural areas.

9. Conclusion

With the then state of the art the alternative of a satellite earth station system was barely considered when the design philosophies were being developed in 1977-8. However in the light of the developments since then, would that alternative be a serious contender today?

Dr. Pelton of Intelsat looked closely at this question at the P.T.C. Conference last year and was firmly of the view that terrestrial links in a situation like this had their place. (Ref. 3)

We can only support and amplify his view. Certainly the system as provided inhibits the centralisation of switching hardware and software possible with a high capacity digital link.

But the advantages of a terrestrial system in the current state of the art are:

1. It can carry junction circuits between exchanges, and as well provide for V.H.F. or cable dial circuits to over 95% of the country. The mountainous terrain, with all the difficulties of construction, provides locations for repeaters for high quality circuits which are ideal for V.H.F. connection to small and isolated communities. The fixed costs of the hill top stations are then spread over all users.
2. The measure of interest in such communities for a telephone within the Vanuatu network was examined in the demand study and the predictions are being confirmed.

Village councils are amongst the first V.H.F. subscribers and constitute a substantial proportion of the pent up demand.

It is expected that the co-operative and private stores throughout the rural areas may well be a popular and suitable location for public use telephones with or without coin boxes.

During the settling down period, the opportunity to shift a telephone a few kilometres to better suit the needs of the population is invaluable and far simpler and less expensive with a V.H.F. installation than with an earth station.

3. The adjustment of call concentrators (ratio of number of junctions to subscribers) to provide an acceptable grade of service and maximise revenue is a straight forward matter.
4. For the small but still significant number of international calls which are transmitted through Vanitel to the satellite system, there is no satellite delay in the domestic network, to add to that currently necessary in the international net.

Was this the right time for the new country of Vanuatu to develop a nation wide common carrier terrestrial system? Decisions taken in 1977 and since have progressively led towards it.

Whilst it is unfortunate that the new exchanges were not provided simultaneously, enabling the proposed zone

charging system to be applied, the acceptance by non subscribers in a rural society with a limited cash economy of up to 180 VT per call indicates the value to them.

By the integration of the terrestrial domestic network with the international satellite network, a basis is there to meet telephone, telex and data demands at a reasonable cost. The integrated approach commended by Dr. Pelton of Intelsat (Ref. 3) has been demonstrated in Vanuatu.

As additional systems become available, perhaps along the lines commended by Jane Hurd last year (Ref. 4) considered decisions will be made as to their usefulness, their cost to the users and the country, compared with, say, supplementation of the terrestrial system.

It is appropriate to note that in the populous country of Indonesia the PALAPA satellite was added to an extensive wide band terrestrial system.

With the ready access of rural people and communities to the administration and political leaders by this telephone system, the information flow will help the making of proper decisions.

Mr. Kirk Huffman, Anthropologist at the Vila Cultural Centre, feels that the newly available system is of a real advantage to villagers and workers in the rural areas, and could be a factor in discouraging migration to the urban areas.

Common carrier authorities deferring decisions on applying current state of the art technology while waiting for the next generation of facilities can produce the reverse effect to that intended - it can force others to develop answers for their own restricted needs, so denying the common carrier funds and traffic when it wants to move.

Was it the right time? We suggest the answer is Yes.

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Fiber Optics in Japan

Shuji Ueda
Sumitomo Electric Industries, Ltd.
Osaka, Japan

1. Abstract

The rapid development of fiber optics has enabled putting optical communication systems into practical use in Japan in various fields such as public telecommunications, electric power controls, traffic controls, industrial communications and controls, computer links, office automations, CATVs, TV broadcastings, automotive wire harnesses, and other systems.

This paper describes the past history and present status of research and development of fiber optics, that is, optical fibers, optical components, optical materials, and practical application systems, as well as future technologies of fiber optics. It also describes the potential markets and future trends of fiber optics in Japan.

2. INTRODUCTION

The first optical fiber in Japan was developed by Nippon Sheet Glass Company in 1969. It was a graded-index fiber called "Selfoc" produced from composite glass materials and having a transmission loss of 200 dB/km.

The first practical installations of optical fibers were conducted by Nippon Telegraph and Telephone Public Corporation (NTT) and electric power companies such as Tokyo Electric Power Company (TEPCO) and Kansai Electric Power Company (KEPCO) from 1974 to 1976.

In 1978, the world's first visual information system using optical fibers, the HI-OVIS (Higashi Ikoma Optical Visual Information System) was established in Ikoma city near Osaka by the Visual Information System Development Association (VISDA) under the guidance of the Japanese government's Ministry of International Trade and Industry (MITI) in cooperation with Sumitomo Electric, Matsushita, and Fujitsu.

These experimental installations of optical fibers have accelerated the increase of their practical use in various fields in Japan.

3. PAST HISTORY AND PRESENT STATUS OF FIBER OPTICS IN JAPAN

3.1 OPTICAL FIBER

3.1.1 STRUCTURE OF OPTICAL FIBERS

The most commonly used optical fibers are silica glass fibers composed of two glass layers. They usually have outer diameter of about 0.1~0.3 mm.

Optical fibers have a higher refractive index portion called the core in the center region and a lower refractive index portion called the cladding in the outer region as shown in Figure 1. The refractive index of the core should always be larger than that of the cladding to transmit the light waves inside the optical fiber.

The number of propagation modes and the patterns of light waves to be transmitted inside the optical fiber depend on the wavelength, refractive index difference between core and cladding, refractive index profile of the core, and core diameter.

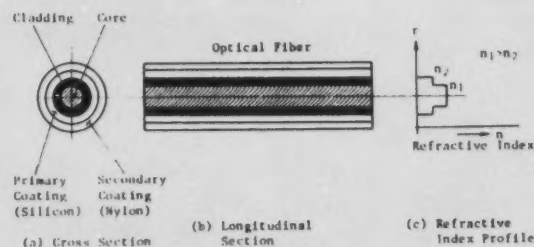


FIGURE 1 STRUCTURE OF OPTICAL FIBER

There are two types of optical fibers: single-mode fibers, which transmit only one mode, and multimode fibers which transmit more than one mode. Based on differences in the core's refractive index profile, multimode fibers can be classified into two types: step-index fibers and graded-index fibers.

The structures and light-wave transmission patterns are shown in Figure 2.

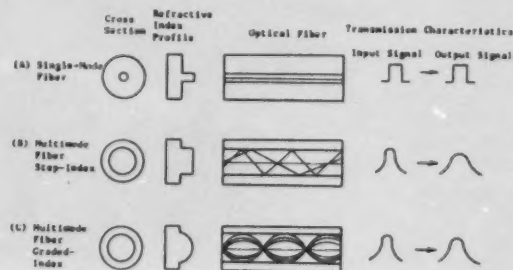


FIGURE 2 STRUCTURES AND LIGHT-WAVE TRANSMISSION PATTERNS OF OPTICAL FIBERS

3.1.2 FABRICATION PROCESS OF PREFORMS

Several methods fabricating optical fibers have already been developed. Silica glass material is mainly used for fabrication of high-quality optical fibers. When optical fibers are made of silica glass material, it is necessary to first make a preform having a refractive index profile quite similar to that desired in the optical fiber.

Several kinds of preform fabrication processes have already been developed in Japan.

The VAD (Vapor-phase Axial Deposition), a new preform fabrication process, has been developed by collaboration among NTT and major cable manufacturers.

It enables production of larger preforms and higher quality fibers. Raw materials supplied with combustion gases to multi-concentric ring burners are converted into fine glass particles containing dopants and then deposited on the end of a seed rod, as shown in Figure 3. When the seed rod is moved upwards while being rotated, the porous preform grows. After heating the porous preform by ring heater, it becomes a transparent glass rod.

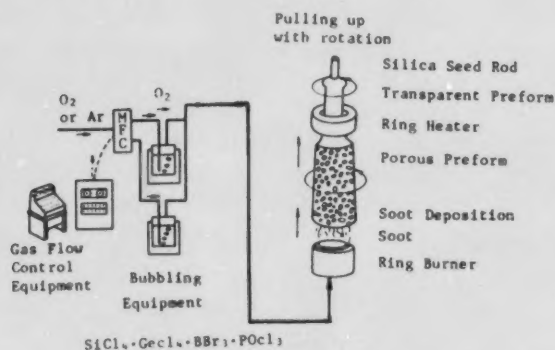


FIGURE 3 VAD PREFORM FABRICATION PROCESS

The VAD method has many significant features: it can produce a large-diameter, long preform continuously, resulting in high-quality fibers with low loss and broad bandwidth. The VAD method, therefore, is the most suitable preform fabrication process for mass production of optical fibers.

3.1.3 FIBER DRAWING AND CABLING PROCESS

It is necessary to protect a glass fiber in order to give it tensile strength sufficient for enduring the cabling and installing processes, because it is originally very fragile due to the glass material.

It has been found by Sumitomo Electric through many experiments that the tight coating method is the best way to make a glass fiber strong in

terms of mechanical strength and stable transmission characteristics.

In this protection method of glass fibers, the bare fiber is coated with silicon resin immediately after drawing in tandem with the drawing process. This is called the primary coating process. After primary coating, the coated fiber is covered with nylon resin by extrusion, as shown in Figure 4.

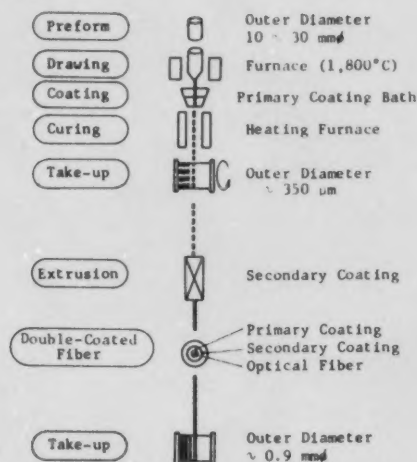


FIGURE 4 FIBER-DRAWING PROCESS

The reinforced fibers are then stranded into a cable together with cushioning materials. The number of fibers and the structure depends on the application. The optical fiber cable is finished after covering it with protective sheathing. The cabling process is shown in Figure 5.

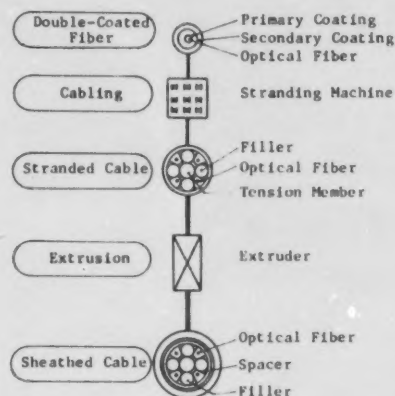


FIGURE 5 CABLING PROCESS

A variety of products are made: optical fiber cords, nonmetallic cables, metal-sheathed cables, figure-8 cables, and power and optical-fiber

composite cables.

3.1.4 CHARACTERISTICS OF VAD OPTICAL FIBERS

The most important characteristics of optical fibers are transmission loss, transmission bandwidth and tensile strength.

Typical data on transmission loss of VAD fibers are shown in Figure 6 and 7. As shown in the former, the transmission loss of a graded-index fiber is about 2 dB/km in the 0.8 μ m wavelength region, 0.5 dB/km at 1.3 μ m, and 0.3 dB/km at 1.5 μ m. This graph shows the transmission loss of VAD fiber is much lower than that of MCVD fiber in the 1.2 μ m to 1.6 μ m region. On the other hand, the transmission loss (Fig. 7) of a single-mode fiber at 1.3 μ m is 0.4 dB/km and 0.2 dB/km at 1.55 μ m.

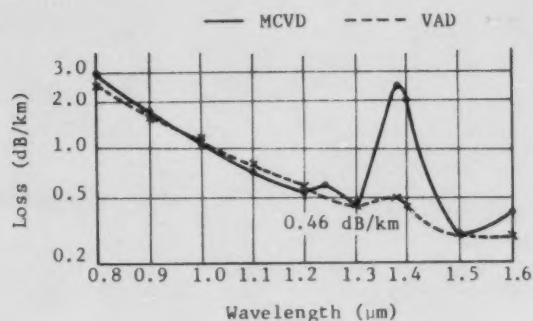


FIGURE 6 TRANSMISSION LOSS OF GRADED INDEX FIBER

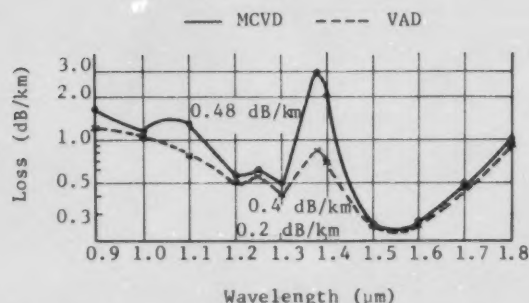


FIGURE 7 TRANSMISSION LOSS OF SINGLE MODE FIBER

Typical data on transmission bandwidth are shown in Table 1. The bandwidth of VAD fibers is greater than that of MCVD fibers.

TABLE 1 TRANSMISSION BANDWIDTH OF VAD FIBER

Type of Fiber	Wavelength	
	0.83 μ m	1.3 μ m
VAD	1.83 GHz·km	4.2 GHz·km
MCVD	1.38 GHz·km	1.96 GHz·km

Typical data on tensile strength are shown in Figure 8. This graph shows that the bare fiber has tensile strength of only 0.3 ~ 1.3 kg/fiber, but a double-coated fiber has tensile strength of 8.7 ~ 10.1 kg/fiber. This data show that the protection process is the most crucial technology for producing strong fibers.

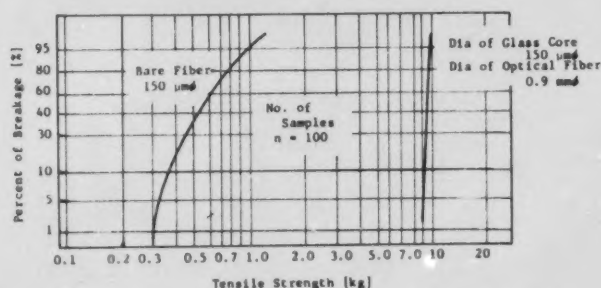


FIGURE 8 TENSILE STRENGTH OF OPTICAL FIBER

3.1.5 SPLICING METHOD

Several kinds of splicing methods have already been developed. They are arc-fusion splicing, V-groove splicing, and connector splicing.

An automatic arc-fusion splicing machine is shown in Photograph 1. The arc-fusion splicing method is the most reliable method for splicing optical fibers. The spliced point of fibers by automatic arc-fusion splicing machine has an average loss of 0.1 dB and excellent characteristics in tensile strength and ability to endure high temperatures, high humidity, and vibration.

3.1.6 TYPICAL OPTICAL FIBERS AND THEIR CHARACTERISTICS

Typical commercially available optical fibers and their characteristics are shown in Table 2.

TABLE 2 THE TYPICAL FIBERS AND THEIR CHARACTERISTICS

Type	Core dia. (μm)	Cladding dia. (μm)	Wave-length (μm)	Trans-mission loss (dB/km)	Trans-mission bandwidth (MHz·km)	N.A.
EG-5/2510	50	125	0.85	2.5	1500	0.2
5/3010	50	125	0.85	3.0	1000	
5/3008	50	125	0.85	3.0	800	
5/3006	50	125	0.85	3.0	600	
5/3508	50	125	0.85	3.5	800	
5/3506	50	125	0.85	3.5	600	
5/3504	50	125	0.85	3.5	400	
5/3502	50	125	0.85	3.5	200	
EG-5/0715	50	125	1.3	0.7	1500	0.2
5/1010	50	125	1.3	1.0	1000	
5/1008	50	125	1.3	1.0	800	
5/1006	50	125	1.3	1.0	600	
5/1308	50	125	1.3	1.3	800	
5/1306	50	125	1.3	1.3	600	
5/1304	50	125	1.3	1.3	400	
5/1302	50	125	1.3	1.3	200	
ES-1/05xx	10	125	1.3	0.5	-	0.1
ES-1/07xx	10	125	1.3	0.7	-	
ES-1/10xx	10	125	1.3	1.0	-	
ET-8/50xx	80	125	0.85	5.0	30	0.25
ET-10/60xx	100	140	0.85	6.0	10	0.28

3.2 OPTICAL SOURCES AND OPTICAL DETECTORS

3.2.1 OPTICAL SOURCES

Optical sources (called E/O converters) change electric signals into optical signals. Semiconductor optical sources such as LEDs (light-emitting diodes) or LDs (laser diodes) have already been developed to meet the requirements of optical communication systems.

Materials based on gallium arsenide (GaAs) and gallium-aluminum arsenide (GaAlAs) are used as light emitters in the region of 0.8 to 0.9 μm wavelength, and indium gallium arsenide phosphide (InGaAsP) is used in the 1.2 to 1.6 μm region.

At present, LEDs and LDs in the 0.8 μm and 1.3 μm regions have been developed and are already commercially available. Laser diodes in the region of 1.5 μm wavelength are now under development.

The present status of manufacturers of optical sources in Japan is shown in Table 3.

TABLE 3 MANUFACTURERS OF OPTICAL SOURCES IN JAPAN
(Commercially available)

Wavelength Optical Source	Short wavelength	Longer wavelength	
	0.8 μm	1.3 μm	1.5 μm
LED	Fujitsu Hitachi Mitsubishi Matsushita NEC Toshiba Others	Fujitsu	Fujitsu
LD	Fujitsu Hitachi Mitsubishi NEC Others	Fujitsu Hitachi Mitsubishi NEC Others	under development

3.2.2 OPTICAL DETECTORS

Optical detectors (called O/E converters) change optical signals into electrical signals. PIN-PDs (PIN-photodiodes) and APDs (avalanche photodiodes) are generally used. Silicon PIN-PDs and silicon APDs are used for short wavelengths around 0.8 μm . InGaAs-PIN-PDs and Ge-APDs are used for longer wavelengths of 1.3 μm and 1.5 μm . InGaAs-APDs are now under development.

The present status of manufacturers of optical detectors in Japan is shown in Table 4.

3.3 OPTICAL COMPONENTS

Optical components include directional couplers, optical dividers, optical switches, optical attenuators, optical fillers, and optical isolators, which have already been developed for optical communication systems.

TABLE 4 MANUFACTURERS OF OPTICAL DETECTORS IN JAPAN
(Commercially available)

Wavelength Optical Detector	Short wavelength	Longer wavelength
	0.8 μm	1.2 ~ 1.6 μm
PD	<u>Si-PIN-PD</u> Hamamatsu TV Kodenshi Kogyo Mitsubishi NEC Sharp Others	<u>InGaAs-PIN-PD</u> Mitsubishi Toshiba
APD	<u>Si-APD</u> Fujitsu Mitsubishi NEC Others	<u>Ge-APD</u> Fujitsu InGaAs under development

Optical directional couplers separate or combine optical signals by using half mirrors. Their insertion loss is 1.0 ~ 1.5 dB, and isolation loss is 35 ~ 40 dB.

Optical dividers separate and combine optical signals equally by using half mirrors. Their insertion loss is less than 2 dB, and isolation loss is larger than 35 dB.

Optical switches change the optical paths by moving prisms or by using optoelectronics materials. At present, 1x1, 2x2, and 4x4 switches have already been developed.

Optical attenuators decrease the optical power by inserting absorbing materials into the optical path. Variable attenuators and stepwise attenuators have already been developed.

Optical fillers are used for wavelength division multiplexing (WDM) and demultiplexing. Four or five optical waves can be transmitted in an optical fiber at the 0.8 μm region.

Optical isolators are used for high-speed modulation or analog modulation of laser diodes. Optical isolators utilize polarization characteristic of material due to the Faraday effect.

3.4 PRACTICAL APPLICATION SYSTEMS OF FIBER OPTICS

3.4.1 PUBLIC TELECOMMUNICATIONS

Public telecommunications service in Japan is monopolized by NTT which had about 40 million subscribers at the end of 1981.

NTT installed its first experimental optical fibers (about 60 km core length) in the Yokosuka Electrical Communication Laboratory in 1975.

In 1978, NTT installed 21 km of 48-fiber optical cables between Karasaka station and Kuramae station in Tokyo as its first field research (FR-1).

Experiments have been done on digital transmission of PCM 6.3 Mb/s, 32 Mb/s and 100 Mb/s, and PDM for analog signal transmission. And in 1979, NTT installed 18 km of 24- and 48-fiber optical cables between Kawasaki station and Shiboguchi

station in Kawasaki city as its second field research (FR-II).

Based on the success of this series of experiments, NTT started in 1981 to install optical cables at 12 sites in major cities such as Tokyo, Osaka, Kyoto, and others for its first commercial test (CT).

The total length of optical cables is about 107 km. The systems for the 12 sites are shown in Table 5. NTT is planning to install optical cables at 31 more sites in 1982.

Furthermore, NTT released a long-term plan for an Information Network System (INS), an integrated network of telephones, facsimiles, data, and video informations. INS is planned as an integrated network for the 21st-century communication system in Japan. The basic concept of INS is shown in Figure 9.

TABLE 5 12 SITES FOR THE FIRST COMMERCIAL TEST BY NTT

City	Site	Bit rate (Mb/s)	No. of fibers	Cable length (km)	Fiber core length (km)
Tokyo	Ocemachi-Aoyama	32	36	8	274
	Tachikawa-Fussa	100	24	13	312
Osaka	Sekino-Kadoma	32	48	10	480
Nagoya	Kariya-Chiryu	100	12	8	96
Kyoto	Kyoto Minami-Sanjo	32	36	8	288
	Sanjo-Kamo	32	36	6	216
Chiba	Chiba-Imai	32	18	6	108
Gifu	Gifu-Kagamihara	100	24	11	264
Kurashiki	Kurashiki-Misushima	32	42	10	420
Nagasaki	Nagasaki-Nagayo	32	12	11	132
Sendai	Tatejogasaki-Aramaki	32	24	8	192
Hokkaido	Tomakomai-Higashi	32	24	8	192
Total		-	-	107	2,974

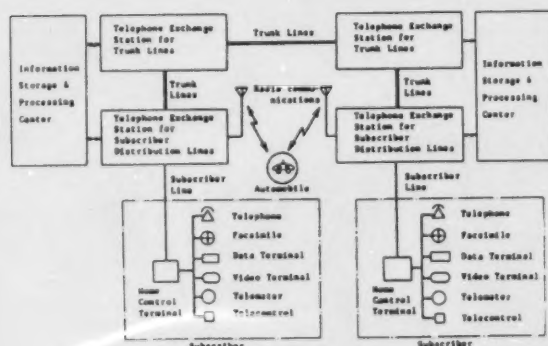


FIGURE 9 BASIC CONCEPT OF INS

3.4.2 ELECTRIC POWER CONTROL SYSTEMS

There are nine electric power companies and one electric power development company in Japan, and their total electric power supply capacity was 150 million kW in 1982.

At present, electric power companies use microwave transmission circuits, telephone cables, and coaxial cables for communications and control systems of electric power transmission networks. But these transmission systems are disturbed by high voltage due to lightning and high-power transmission lines. Thus, electric power companies need more reliable communication and control systems in order to keep up with the increasing voltage of power transmission systems and the complexity of electric power transmission networks caused by the rapid increase in electric power demand.

TEPCO and KEPCO started a joint research and development with major cable and equipment manufacturers, in 1974, of optical fiber applications for electric power control systems.

In 1975, TEPCO installed 2.2 km of nonmetallic 4-fiber optical cables between its Honten (head office) and Minami Tokyo Denryokusho (South Tokyo substation) for an experimental digital transmission system of 8.7 Mb/s. On the other hand, in 1974, KEPCO installed a short optical cable of 200 m in its Central Technical Laboratory in Amagasaki City.

These two systems were the first experimental installations of optical cables in Japan.

After these experiments, TEPCO installed 2.9 km of 4-fiber optical cables in the Shinjuku area of Tokyo for PCM 1.544 Mb/s transmission, 2.9 km of 4-fiber cables in Kannai of Yokohama, and 3 km of 4-fiber cables in the Tabata of Tokyo in 1976.

KEPCO installed 2 km of 4-fiber cables between its Honten (head office) and Nakanoshima Center Building in Osaka, 3.5 km of 4-fiber cables Kita-ku in Osaka, and 1.5 km of 4-fiber cables in Okibe of Higashi Osaka (east Osaka) city.

These experiments by the two companies have accelerated the usage of optical cables in electric power control systems in Japan. Systems for measuring wind speeds and directions, lightnings, and water levels of storage dams have been developed by electric power companies.

A substation surveillance and control system is shown in Photograph 2.

3.4.3 RAILWAY AND HIGHWAY TRAFFIC CONTROL SYSTEMS

(1) RAILWAY TRAFFIC CONTROL SYSTEMS

Optical communication systems have already been applied by the Japanese National Railways (JNR), private railway companies, subways, and new transit system in Japan. At present, video information systems are mostly used for surveillance of platforms, stairways, escalators, and ticket-vending machines. Large-scale optical communication systems have been installed in the new transit systems of Osaka Port Town and Kobe Port Island to enable completely automated operation in the future. A surveillance system

of ticket-vending machines, wickets, stairways and escalators is shown in Photograph 3.

In case of subways, surveillance systems of platforms using optical video transmission systems have already been installed in Tokyo, Kyoto, Fukuoka, and Sapporo subways. And, JNR and private railway companies have also installed such surveillance systems at stations and marshaling yards.

(2) HIGHWAY TRAFFIC CONTROL SYSTEMS

The first traffic control system using optical cables on highways was installed on the Osaka-Matsubara line by Hanshin Expressway Public Corporation in 1980. The cables used in this 14 km-long system are composite cables of 600 V power cables and 4-fiber optical cables. A similar system was installed between Osaka and Kobe (35 km) in 1981. The function of this system is to observe real-time traffic flow along highways using many TV cameras and monitors.

3.4.4 CABLE TELEVISION SYSTEMS

The most promising application field of optical fibers other than telecommunications is predicted cable television.

Cable television systems in Japan have about 3 million subscribers and 28 thousand individual systems in all. This figure shows that each system is very small and the penetration rate of cable television is still very low. But the number of subscribers is expected to increase very rapidly.

In 1978, an experimental system of cable television using optical fibers was installed in Higashi Ikoma near Osaka by VISDA under the guidance of MITI in cooperation with Sumitomo Electric, Matsushita, and Fujitsu.

Called HI-OVIS (Higashi Ikoma Optical Visual Information System), this system is the world's first large-scale two-way cable television system using optical fibers, as shown in Figure 10.

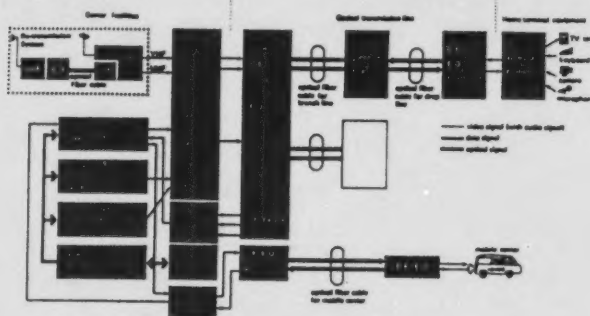


FIGURE 10 SCHEMATIC DIAGRAM OF HI-OVIS

This is a complete interactive cable television system capable of transmitting 29 channels from a

center to subscribers and one TV channel, one voice channel, and data channels from each subscriber to the center. It has about 170 subscribers.

Plans are made by the Academic New Town Community Cable Service (ACCS) for installing a two-way cable television system with more than 20,000 subscribers, in Tsukuba Academic New Town by 1985.

3.4.5 OTHER APPLICATION SYSTEMS

Optical communication systems have already been applied in various fields of factories and plants, computer networks, TV broadcastings, medical information systems, and automotive wire harnesses.

In factories and plants, data-highway systems and process control systems using optical fibers have already been installed in large steel manufacturing factories and petrochemical plants.

In computer networks, optical data links are used between CPU and a few terminals, and between CPUs. A Research Information Processing System (RIPS), a large-scale computer network linking nine laboratories by 360 km of optical cables was installed in Tsukuba Academic New Town in 1980.

In the field of automotive wire harnesses, the Nissan Cedric, Nissan Gloria, and Toyota Century have already been equipped with optical fiber harnesses.

An optical data-highway system for office automation was installed in a corporate office building in Tokyo in 1982. This is the first such application of optical fibers in a building in Japan.

4. FUTURE TECHNOLOGIES OF FIBER OPTICS IN JAPAN

Technologies of fiber optics can be divided into three generations. Optical communication systems composed of optical transmitters, optical fibers, and optical receivers are defined as the first generation. Optical systems which employ partially optical processors such as optical sensors, optical actuators, and optical devices are defined as the second generation. In the future, it will be possible to transmit image patterns themselves directly through optical systems. These optical systems which can process by optical signals only using optical sensors, optical actuators, optical exchange switches, optical memories, and optical computers are defined as the third generation. The technologies for the second and third generations will be described below.

4.1 IMAGE FIBERS

Image fiber is newly developed imaging system

consisting mainly of bundled pure-quartz fibers, through which images of objects can be directly transmitted over distances longer than 100 m. Image fiber consist of 30 to 50 thousand element fibers with about 10 μ m diameter, is shown in Figure 11 and the picture through image fiber is shown in Photograph 4.

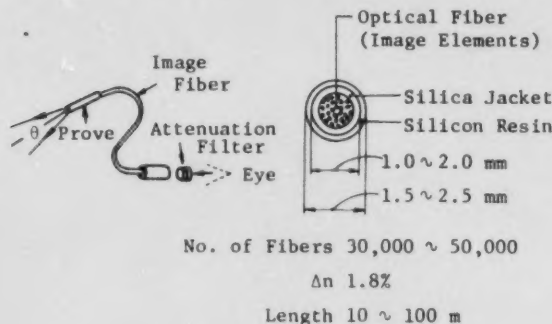


FIGURE 11 STRUCTURE OF IMAGE FIBER

Image fibers are already used in many factories for observation systems in areas of high temperature, high humidity, and high magnetic field intensity.

In the future, they will be used for observation systems in high-radiation areas of nuclear power generation plants.

4.2 NEW OPTICAL FIBERS IN THE RANGE OF INFRARED LIGHT WAVELENGTH

Silica fibers have the maximum transmissible wavelength about 1.6 μ m, so new optical fibers with 2 ~ 20 μ m infrared light wavelength are now under development in Japan. Materials will be used for infrared light wavelength optical fibers are now under development, and at present, alkali halides are considered to be the most promising materials at 10.6 μ m for CO₂ lasers. Infrared optical fibers at 10.6 μ m, can transmit not only optical energy, but also optical communication signals.

4.3 COMPOUND SEMICONDUCTOR MATERIALS

III-V compound semiconductor materials such as gallium arsenide (GaAs), gallium phosphide (GaP), indium phosphide (InP), and indium antimonide (InSb) are very important for optical materials. Technologies, for growing III-V compound semiconductor ingots are highly advanced, and high-quality materials are promoting applications of optical communication systems in Japan.

4.4 BSO OPTICAL MATERIAL

Bismuth silicon oxide (Bi₁₂SiO₂₀, or BSO for short) is a new optical material having various unique characteristics; photoconductivity,

electro-optic effect, and piezoelectric effect. It can be used for image sensors, electronic optical switches, and sensors to measure physical distortion as well as voltage and electric-field density. A BSO single crystal is shown in Photograph 5.

4.5 ZnSe OPTICAL MATERIAL

Zinc selenide (ZnSe), a II-VI semiconductor material, has been developed as a new optical material. It can be used for windows, mirrors, half mirrors, and lenses for heavy-duty industrial CO₂ laser manufacturing machines. Photograph 6 shows ZnSe single-crystal wafers.

4.6 OPTICAL SENSORS

Optical sensors for measuring physical displacement, temperature, sound pressure, electric field density, blood flow speed, revolution speed, and etc. are now under development. A basic concept of optical gyroscope is shown in Figure 12.

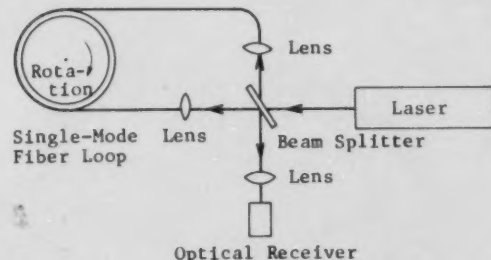


FIGURE 12 BASIC CONCEPT OF OPTICAL GYROSCOPE

4.7 OPTICAL INTEGRATED CIRCUITS (OIC)

It is possible to fabricate optical transmitters, optical amplifiers, optical modulators, optical demodulators, optical transmission elements, and optical receivers into one package using semiconductor materials such as GaAs, InP, and others. An example of an optical IC (OIC) under development is shown in Figure 13.

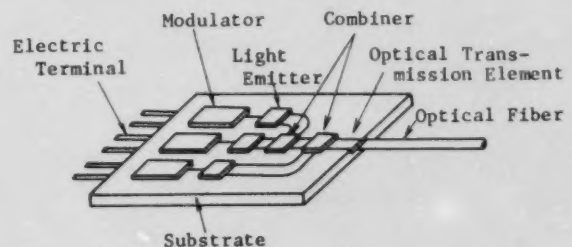


FIGURE 13 OPTICAL INTEGRATED CIRCUIT (OIC)

4.8 OPTICAL COMPUTERS

Optical computers will be developed in the near future, because they can compute and process optical signals much faster than electronic computers do, and also their dimensions would be much smaller than conventional ones.

Optical computers are classified into analog and digital computers. An analog computer can process image patterns directly, so it will be the most important key hardware for video information networks in the near future.

5. POTENTIAL MARKETS AND FUTURE TRENDS OF FIBER OPTICS IN JAPAN

5.1 POTENTIAL MARKETS OF FIBER OPTICS

Demand for fiber optics has not yet grown on a large-scale, but exceptionally rapid growth is predicted for the fiber optics market in Japan in the near future.

The present and potential markets of fiber optics in Japan estimated and predicted by the Optoelectronic Industry and Technology Development Association are as follows. In 1980, the total production sale of fiber optics was 83 billion Yen (\$332 million, at \$1.00 = ¥250) and the potential markets in 1985 are 490 billion Yen (\$1,960 million), 1 trillion Yen (\$4 billion) in 1990, and 6 trillion Yen (\$24 billion) in 2000.

The average annual growth rate is expected to be about 65% from 1980 to 1985, about 28% from 1985 to 1990, and about 29% during the 10 years from 1990 to 2000. The largest market of fiber optics is in the field of telecommunications, accounting for over 60% of the total market.

5.2 FUTURE TRENDS OF FIBER OPTICS

Based on national research and development programs, several large-scale projects depending on or utilizing fiber optics are in progress. They are Flexible Manufacturing System Complex provided with laser (FMC, for short), optical measurement and control system, subsea oil production system (SPS, for short), and manganese nodule exploitation sponsored by MITI. The main object of these projects is to develop basic technologies of manufacturing processes and/or fiber optics applications. These projects are promoting fiber optics applications in various fields of industry other than telecommunications in Japan.

On the other hand, NIT has a plan to establish its Information Network System (INS) using optical fibers throughout Japan by 2000. INS will create a new demand for fiber optics and a new market of over 20 trillion Yen in total.

Japan is now faced with many difficulties of traffic congestion due to overpopulation in urban

areas, mass education, medical care for aged people, shortage of natural resources, and energy. Optical communication systems will establish an infrastructure for an advanced information society and will definitely play an active role in mitigating and solving these problems.

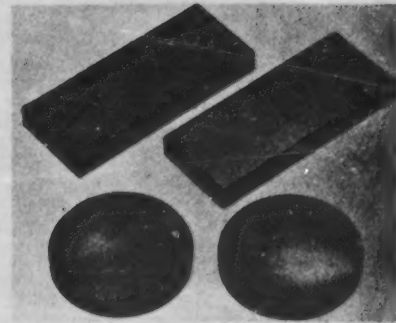
The advanced information society in which each home will be connected with a telephone exchange office center and cable television office center by optical fibers is called OPTOPIA by Chairman Mr. Kamei of Sumitomo Electric, and Sumitomo Electric is trying to do best its realization steadily step by step.



PHOTOGRAPH 1 AUTOMATIC ARC-FUSION
SPlicing MACHINE



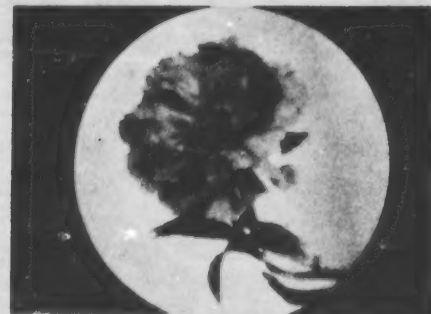
PHOTOGRAPH 5 BSO SINGLE CRYSTAL



PHOTOGRAPH 6 ZnSe SINGLE-CRYSTAL
WAFERS



PHOTOGRAPH 2 SUBSTATION SURVEILLANCE AND
CONTROL SYSTEM



PHOTOGRAPH 4 TRANSMITTED IMAGE OF FLOWER
THROUGH IMAGE FIBER



PHOTOGRAPH 3 SURVEILLANCE SYSTEM AT STATION OF
NEW TRANSIT IN OSAKA PORT TOWN

Meteor Burst Communications Systems

George E. Westwater
George E. Westwater & Associates
Honolulu, Hawaii

INTRODUCTION

Meteor Burst Communications Systems utilize ionized meteor trails for radio wave propagation. This method of transmission is a proven, currently-operational system for data exchange. Useful ranges extend from 0 to 2000 km with greater distances achieved by relays. Although a "burst" mode of communications, real time data rates exceed 100 words a minute when using a full duplex link.

Single, fixed frequency operation allows use of relatively simple, unsophisticated equipment.

Because, unlike the ionosphere, meteor trails are limited in extent, the "footprint" at the receive site is quite small. This characteristic makes meteor trail transmissions extremely difficult to jam or intercept. Since the signal format used is readily encrypted, total security is easily obtained.

As propagation is independent of the ionosphere, meteor burst provides immediate communications capability after a nuclear event.

Meteor Burst has the tremendous advantage of total ownership and control by the buyer. No outside agency can place any restrictions on the owner's use of his equipment. Ownership also brings operating costs down to a fraction of satellite charges.

COMMUNICATION METHODOLOGY

Meteor burst communications is probably the least known of the many methods available for achieving long range data telecommunications. Commonly used methods include:

1. Telephone line/coaxial cables
2. VHF repeaters
3. Microwave links
4. Satellites
5. HF SSB
6. Troposcatter

Telephone lines/coaxial cable systems require continuous cables interconnecting each station in the system. The lines if above ground are vulnerable to deliberate or inadvertent outage. If below ground, construction costs are increased considerably.

VHF repeater systems and microwave systems require towers at line-of-site distances which are highly vulnerable to deliberate or accidental outage.

Prime power is required at each repeater site and additional tower sites must be added to expand the system.

Just a few years ago satellites, although quite costly, were thought to be the answer for long range communications. Now, however, second thoughts are being given to total dependency on satellites, especially for military communications. Because of excessive susceptibility to jamming and destruction, long lead time for replacement, earth station vulnerability and other factors, considerable effort is being directed to providing alternate systems.

For small nations, dependency upon an outside agency or state for internal satellite communications could actually restrict national development should this foreign owner decide to raise rates or limit access.

The other two methods, HF SSB and troposcatter, depend upon the ionosphere for propagation, with HF SSB by far the more predominant. Most communicators are familiar with the vagaries of HF SSB communications: separate frequencies for day and night because of the change in height of the ionosphere, back up day and night frequencies because of interference on the primary frequencies, getting authorization for the several frequencies needed for the particular path, fading, skip distances, Maximum Usable Frequency, Frequency of Optimum Transmission, the effect of the Aurora Borealis in northern latitudes, scrambler for protection, and so forth.

METEORS AND METEOR TRAILS

Meteors about the size of a cantalope and weighing 10 to 25 kg occur at a rate of about 10 per day. Meteors with a diameter as small as 0.8 mm (about the thickness of a fingernail) occur at a rate of 2 to 8 billion (1000 million) per day or 50,000 per second. The ionized trails of these numerous tiny meteors provide the directional antennas for Meteor Burst communications.

Meteors are extra-terrestrial objects that travel in elliptical orbits around the sun. Shower meteors are the most spectacular and best known by most people since they arrive on a regular basis. However, they account for a very small fraction of the meteors that are available for radio use. The communications workhorses are the many sporadic meteors that move in random orbits about the sun. They are called sporadic because their radiants and times of occurrence cannot be cataloged as shower meteors can. When a meteor's orbit coincides with the earth's orbit, the meteor enters

the earth's atmosphere at a speed of 10 to 75 kilometers per second, thus possessing a large amount of kinetic energy.

As the meteor collides with atmospheric air molecules, the kinetic energy is converted into heat which vaporizes atoms from the meteor's surface. The vaporized atoms are further restricted by air molecules, which ionize while stripping electrons from the atoms. This causes a trail behind the meteor of positively charged ions and free electrons. This trail will reflect or re-radiate radio waves depending on the electron density of the trail (proportional to the size of the meteor).

The ionized trail is distributed in the form of a long thin paraboloid, with the particle at the head. The head of the trail has a radius of about 1 meter, with a trail length of about 25 kilometers. The speed and size of the meteor trail defines the communications time period for each meteor.

Literally billions of meteors large enough to give usable ionized trails enter the earth's atmosphere every day. The trails are categorized for communications use as being over-dense or under-dense, with an electron density of 10^{14} electrons/meter being the crossover point. Over-dense trails are too dense for the radio signal to penetrate. In this case, the radio signal is reflected from the electron trail. When the trail is under-dense, the radio signals pass through the trail and in passing excite each individual electron. The excited electrons act as small dipole antennas to actually re-radiate the signal.

Both over-dense and under-dense trails act as directional antennas to provide useful communications. In both cases, the angle of arrival of the signal is equal to the angle of departure from the trail. Since the useful trails exist in a region 95 to 115 kilometers above the surface of the earth, simple triangulation, taken in conjunction with the curvature of the earth, resolves into a maximum communications range of 2000 kilometers. Note, however, there is no minimum range! Thus, a Meteor Burst System can provide communications over a range of 0 (line of sight) to 2000 km with no change in the system.

The nominal meteor orbits are such that there are a maximum number of meteors intersecting the earth's orbit in the month of August and a minimum number in February with a variation of about 3 to 1.

On the morning side of the earth, meteors are "swept up" because of the earth's orbit. On the evening side, the only meteors reaching the earth are those which "catch up" with it. A daily or diurnal variation of 4 to 1 is usually experienced. Evening side meteors, though fewer in number, are travelling slower and thus provide longer periods of communications.

PRINCIPLE OF OPERATION

There are two types of stations in a meteor burst network: a Master Station that controls the system, and a group of working stations referred to as Remote Stations. The Remote Stations can be Remote Communications Terminals with a KSR teleprinter, or Remote Data Terminals with meteorological/hydrological sensors, oil and gas drilling sensors, navigational receiver inputs or any type of data source. Remote Stations can be any combination of both communications and data terminals. Up to 2000 Remote Stations can be controlled by one full duplex Master Station.

The operational scenario of a meteor burst system is similar to any polled network. The Master Station transmits a continuous, coded probe signal; usually in the 40 to 50 MHz band. The probe signal can be an "all call" signal for any station to answer or a specific station call signal. A meteor's ionized trail reflects that signal to a receiving Remote Station. The Remote Station decodes the signal, turns on its transmitter and transmits a signal back along the same path to the Master Station. Information can be sent in either direction until diffusion reduces the electron density in the trail to a value too low to sustain communications.

The maximum length of a single-hop link is about 2000 kilometers, a distance determined by the height of the meteor burn-up region and the curvature of the earth.

The typical meteor trail has a useful duration of a few hundred milliseconds. Waiting times between suitably located trails can range from a few seconds to minutes depending on time of day, time of year, and system design factors.

Meteor Burst transmissions consist of ten of hundreds of characters separated by periods of silence. One important by-product of the burst characteristic and small "footprint" of the received signal area is the ability of many links to share a common transmission frequency, a feature important in data collection networks.

The information exchange can consist of short messages such as sensor data readout, coded messages of up to several hundred characters, text messages of a few words or long messages achieved by "splicing together" packets.

Performance of Meteor Burst systems can be measured in terms of "data through-put" or the amount of "waiting time" required to transmit a message between two stations. In one case, message traffic volume is the primary concern. In the other, length of time required to establish the communications path is the guiding factor.

Equipment parameters that affect system performance are operating frequency, transmitter power, antenna gain, receiver threshold level and data rate.

Operating Frequency

Meteor trails will reflect or re-radiate radio signals from 30 to 200 MHz. Below 30 MHz, the ionosphere F layer will reflect the signal independently of the meteor trail causing non-meteor scattering, interference and reduced range. Above 50 MHz the signal attenuates rapidly with frequency, thus requiring higher transmitter power to achieve the same signal strength. In general, the 40 to 50 MHz range is preferred to minimize antenna size and allow practical levels of RF power.

Transmitter Power

Higher transmitter powers shorten message waiting time. This allows use of smaller meteors and extends the useful life of all trails.

Antenna Gain

Increasing antenna gain is nominally equal to increasing transmitter power. However, the narrow beamwidth of a directional, high gain antenna results in less sky illumination area reducing the number of meteors available for use. The practical limit on antenna gain is a function of operating range and is one of the factors taken into account in the design of a system. Normally, 5-element Yagi antennas are used at the Master Station and a dipole is used at the Remote Station to minimize equipment cost and simplify antenna mounting requirements.

Receiver Threshold

This is defined as the signal level required to achieve a particular Bit Error Rate (BER). The receiver threshold is a function of the specified BER, the type of modulation used, the noise figure of the receiver and the man-made noise level at the receiving site. The lower the threshold, the shorter the waiting time. A typical receiver threshold of -114 dBm will achieve a BER of 10^{-3} at 4 kbps on 45 MHz.

Data Rate

Practical data rates range from 2 to 4.8 kbps. Rates below 1 kbps are not practical because of the length of time required for "over-head" functions, such as receiver start up, bit sync time and word sync time.

Authorized RF bandwidth may restrict the upper limit of the data rate. For example in the United States the bit rate is required to be less than $\frac{1}{2}$ the authorized bandwidth in coherent PSK systems. At nominal data rates, meteor burst systems can operate in a 25 kHz channel. The meteor trail can, however, support greater than 5 MHz instantaneous bandwidths, sufficient to capture one frame of a TV picture.

The total data throughput is influenced not only by the data transmission rate, but also by the operating mode of the equipment: broadcast,

half-duplex or full duplex.

The data rate between a full duplex Master and a half-duplex Master is about 85 words per minute. The data rate between two full duplex Master Stations will exceed 100 wpm in each direction as a daily average throughout the year. If half-duplex Master Stations are used, the data exchange between them will average 70 wpm.

Broadcast mode is relatively inefficient since there is no feedback to indicate receipt of message. However, for short messages to a small group of stations, it can be very practical.

Operational use has shown that a full duplex Master Station can exchange information with a group of 60 half-duplex Remote Stations in less than 5 minutes.

Throughput will vary with the range between stations because of the length of time the trail can be illuminated.

SYSTEMS CONFIGURATION

Three basic equipment configurations are used in current operating systems: Master Stations (full or half-duplex), Remote Data Terminals, and Remote Communications Terminals.

Master Station

The Master Station controls the network by sending out a probe to identify and illuminate the meteor trail that will provide communications between it and a remote terminal or another Master Station. When the path is established the remote unit responds with its data, receives an acknowledgement from the Master Station and returns to the receive mode.

When the Master Station operates in the full duplex mode, it transmits continuously on one frequency while the remote unit responds on a different frequency. When the Master Station is operating in the half-duplex mode, it transmits a probe and waits for a reply on a timed basis until a communications path is established. The exchange will continue on a timed transmit/receive duty cycle until the message is complete and acknowledged or the path is lost.

For maximum message throughput, short message blocks are used with transmission time sized for the longest meteors. A block pointer is used in the probe signal to indicate where the message was lost and where transmission should start.

All operation is under computer or microprocessor control, in both the full duplex and half-duplex modes, to enable rapid response times during the intermittent communications periods available. The Master Station computer controls both communications protocol and dissemination of the received information.

The received data, after processing, can be routed

to a teletype printout, CRT display, another computer or data modem for transmission over wire lines or microwave links to users or data collection centers.

The Fixed Master Station equipment is normally contained in a 19 inch equipment rack 5 feet high. It consists of a receiver, 70 watt exciter, 500 watt or 1 kilowatt continuous duty power amplifier (depending upon desired communication range and throughput), computer and diskette for data storage.

The antenna varies depending upon requirements, but a simple 5-element yagi is commonly used. Operation can be with a duplexer or a single antenna, or with duplex filters using separate transmit and receive antennas.

Transmit and receive frequency separation for a full duplex system is greater than 1.6 MHz to avoid broadcast band intermodulation distortion.

Each 1 kW fixed Master Station can control up to 2000 Remote Stations.

500 watt portable half-duplex Master Stations are also available for field use where fewer Remote Stations are used and good portability is required. A portable Master Station can support up to 1000 Remote Stations and is packaged in four self-contained assemblies each weighing about 25 pounds. In addition, an antenna and mast are required along with primary power.

Remote Communications Station

A Remote Communications Station consists of a 300 watt, 10% duty cycle, solid state transmitter, receiver, microprocessor and rechargeable batteries, all contained in a small portable (25#) equipment case.

An operator terminal is required for input and retrieval of messages.

The antenna is a dipole or small Yagi antenna requiring a 3 to 10 meter tower depending on range.

Power to recharge the 36 VDC batteries can be provided by AC power mains, a vehicular power system or solar panels.

Remote Data Station

The Remote Data Station consists of a 300 watt, 10% duty cycle, solid state transmitter, a receiver and a microprocessor-controlled data interface. Conditioning interface modules are available to handle up to 16 sensors for data collection applications.

A single antenna tower up to 10 meters high (depending on system parameters) is used to mount a dipole or small Yagi antenna. A solar panel for battery charging, sensors as required and a NEMA 4 watertight enclosure containing the electronics, batteries, and signal condi-

tioning interface complete the station.

The Remote Station is designed for reliability, portability and low cost since it may be used in isolated locations.

Equipment Self Test

Built In Test Equipment (BITE) is designed into the Meteor Burst Master Station equipment. The BITE monitors system operation notifying the station operator with both an audible alarm and terminal printout if a fault is detected.

Periodically, the control computer automatically generates a self-test data pattern that is used to modulate a BITE transmitter. The modulated RF output from the transmitter is picked up by the station receiver, which then returns demodulated test data to the computer for comparison with the data transmitted. Test results are printed on the teleprinter. In this manner, the receiver and control computer are functionally checked. If the computer stalls and is unable to pass the self-test, an alarm is sounded.

In addition to this test, if power level or antenna VSWR goes up, an alarm is sounded. The Remote Station equipment is automatically tested at "Power-On" for nominal receiver, transmitter and antenna system parameters.

METEOR BURST OPERATIONS PROCEDURE

Meteor Burst communication is one computer talking to another. Anyone who can use a teleprinter can operate a Meteor Burst station. Only a single fixed frequency or pair of frequencies is used regardless of time of day, season, sunspot cycle or atmospheric anomaly; therefore, there are no operator controls or adjustments to be made.

To communicate by meteor burst, the Remote Communications Station operator types the message he wishes to send on the terminal keyboard. The computer automatically inserts an SOM (start of message) and EOM (end of message) character. The information is stored in the transmit buffer until the Master Station probe, asking for the data, is received at the Remote Communications Station. Alternatively, the Remote Communications Station sends a signal telling the Master Station it has information for it.

At Remote Data Stations, sensors send information to the transmit buffer rather than through a keyboard; otherwise, operation is the same.

If message length is such that it takes more than one meteor trail to transmit the full text, the Master Station stores the received text from successive meteor trails until the EOM character is received. After receipt of the EOM character, Master Station "splices" the stored message together which is then printed out as continuous text.

CURRENT OPERATIONAL SYSTEMS

There are two major meteor burst systems in daily use today in the United States. The first and foremost is the U. S. Department of Agriculture's SNOTEL system which has been operational since 1976. The second is the Alaska Meteor Burst Communications System (AMBCS) which is owned and operated by five federal agencies.

The SNOTEL (SNOpack TELelemetry) system currently contains over 500 Remote Data Terminals. Remote data acquisition sites are spread over 11 U.S. western states feeding data on request to two Master Stations, one at Boise, Idaho, and one at Ogden, Utah. The unattended sites are located in remote regions where power is unavailable and are, therefore, using battery power with solar panel recharging. The sites use various sensors to gather data on snow cover, temperature, precipitation, stream level, etc. The remote stations vary depending on the type of data required. Some stations will perform local data processing to provide max/min and average conditions over a 24-hour period. Some of the more recent sites installed are microprocessor-controlled and provide event-reporting as well as data averaging.

Some of the most recent installations are situated around the Mt. St. Helens volcano where event-reporting of sudden moisture and temperature changes is used to alert authorities to the threat of impending floods.

These sites are unique compared to normal data gathering sites, since they respond to polling commands from the Master Stations as well as to their own event recorders. If critical data is noted from a sensor, the remote station will immediately broadcast requests (on a 10% duty cycle) to the two Master Stations to inform either or both of them of a critical event. The Master Station(s) then selectively address the requesting station to establish communications and acquire the data. Recently, one of the Mt. St. Helens stations reported snow to a depth of almost 20 meters, which, had there been an unusual thaw would have caused catastrophic floods because of the denuded landscape.

The second major operational system in the United States is the Alaska Meteor Burst Communications System (AMBCS). It's owned and operated by five U.S. Federal Agencies sharing a single Master Station in Anchorage. The AMBCS system includes both Remote Data Terminals and Remote Communications Terminals reporting to the Master Station. The Government Agencies involved are the U.S. Army Corps of Engineers, The U. S. Bureau of Land Management, The U.S. Department of Agriculture, The U.S. Geological Survey and the U. S. National Weather Service.

The information being sensed and communicated includes the following:

- Air temperature, wind speed and direction, precipitation, snow pack, humidity and

river stage.

- Message communications from remote Bureau of Land Management survey camps, using portable Remote Communications Terminals.
- Flight weather data from remote air fields for the FAA flight weather service, using both Remote Communications Terminals and Remote Data Terminals.
- Gulf of Alaska wave and wind data from buoys located near Kodiak.

The AMBCS system operates 24 hours a day with the Master Station continually interrogating the remote sites for data. The weather data for the FAA is picked up every half-hour for use on the next hourly broadcast and contains a synopsis of the preceding hour of sensor readings. Even though the system is in use 24 hours a day, it is still capable of supporting many more remote terminals.

AMBCS has operated successfully for over three years in this multiple application mode. The auroral environment that blanks out HF communications for long periods of time has little effect on short message Meteor Burst operation, even in high sunspot activity times.

Other Non-Military Applications of Meteor Burst

Another application that has found repeated use is the combination of a LORAN C receiver with a Meteor Burst data terminal for transmitting mobile station position data. A super tanker was tracked from Valdez, Alaska south to the Strait of Juan de Fuca (near Seattle, Washington). An extension of this application is the position monitoring of icebergs and drifting buoys.

The U. S. Federal Emergency Management Agency (FEMA) recently bought two portable Master Stations and a number of Remote Communication Terminals for rapid deployment to any disaster area in the United States for establishing immediate emergency communications. These highly mobile units will be transported to disaster areas of floods, hurricanes, tornadoes, volcanic eruptions, etc., where conventional communication means have become disrupted. The Meteor Burst units will be used to communicate short message situation reports.

U.S. MILITARY PROGRAMS

Early meteor burst studies led to several developments by U. S. military communications agencies. During 1972-74, a Navy Ship-to-Shore teletype system was developed. This was followed by a flight following demonstration where a LORAN C receiver was used to drive a meteor burst transmitter to automatically give the position (location) of both fixed and rotary wing aircraft. Position following was also adapted for Navy ship-board use and used to track an aircraft carrier from Seattle to San Diego, even to detecting the ship making a turn for a man overboard drill.

Meteor burst was also demonstrated for use in the MEECN system (Minimum Essential Emergency Communications Network) for both a 500 mile link and an 1100 mile link. The space diversity characteristics were demonstrated, performance analyzed, and the nuclear effects evaluated. A nuclear explosion which would interrupt long range HR communications for extended periods of time by disrupting the ionosphere and eliminating normal HF propagation modes will not affect short message meteor burst communications, since meteors will continue to enter the earth's orbit. Communications via meteor burst will be very survivable for the post-nuclear attack demands.

Long range air-to-ground communications were demonstrated for the Defense Communications Agency (DCA) and MEECN agencies between an aircraft over Texas and a ground station in Ohio. This was followed by a demonstration of remote data collection for the Army REMBASS system (REMOte Battlefield Sensor Systems).

New applications of Meteor Burst Communications for military use are showing up rapidly. A high altitude balloon carrying a store-and-forward relay was operated by the U.S. Navy in early 1981 to evaluate airborne range extension beyond the normal 2000 km communications range. A range of over 5000 kms was achieved in these tests. A ship-to-ship communications system for short messages via a Master Station store-and-forward relay was also operated by the U.S. Navy.

The U.S. Air Force will be installing a full duplex point-to-point system to be put in operation very shortly. The performance should exceed several hundred characters per minute as a daily average capability. This system will employ 1000 watt transmitters, bi-phase PSK modulation, and mini-computer control. Each terminal will have computer control instrumentation to measure pertinent statistical information on the link operation.

SUMMARY

Meteor Burst is a proven, currently operational, highly reliable mode of communications. Since it utilizes the ionized trails generated by the billions of meteors entering the atmosphere each day, it is independent of the ionosphere.

Although not usable for voice, at data rates up to 100 words per minute, meteor burst has virtually unlimited applications for both domestic and military applications.

The small footprint, burst technique and randomness of meteors themselves make Meteor Burst both jam resistant and non-detectable. If additional security is required, the transmission is easily encrypted.

Using a fixed frequency, the equipment is simple to operate and maintain.

The Remote Stations are small, lightweight and

highly portable.

A single full duplex Master Station can control up to 2000 Remote Stations.

Operational range is 0 to 2000 km, but it can be extended through store-and-forward relay stations.

Two extensive Meteor Burst Systems are operational in the United States--the 500 station SNOTEL data collection and the Alaska Meteor Burst Communications System (which includes both data and communication terminals in the system). Both of these systems are being expanded and additional Meteor Burst Systems are being planned and implemented each year by the United States Government.

Panel Discussion

"Business Applications/User Needs for Telecommunications"

Notes

International Telecommunications Services
and the Business User

T. Patrick French
Director - PTT Liaison
American Express Company
Brighton, England

This paper raises Telecommunications Regulatory and International Information Flow issues which are, or appear to be, poised to affect the business user of international telecommunications services, and calls for greater consultation with user groups in determining National Regulatory Policies for Telecommunications Services and Information Flow of an International nature.

INTRODUCTION

Technology - and the technology of telecommunications in particular - is developing at an almost frightening rate. We can apply some telecommunications aspects to those given by Alvin Toffler in his book "Future Shock", where he pointed out (in 1970) that when considering the last 50,000 years of man's existence on this planet - using a time scale of one lifetime equating to 62 years - these 50,000 years equate to 800 lifetimes. For the first 700 lifetimes man lived in caves, there has been recorded history for only about 70 lifetimes, and widespread use of the printed word only during the last 6 lifetimes. It is possible to add: telegraphy and telephony emerged during the last 2 lifetimes, and in the last lifetime we have seen developments like Radio, Microwave, Coaxial Systems, Television, Telex, Satellite Communications, Lasers, Data Services, and Computers. Technology is currently moving through the phase of such telecommunications based developments as Optical Fibres, Videodiscs, Electronic Funds Transfer, Videotex and Home Computing.

Gone are the days when the only means of using telecommunications to pass the written word were telegraph and telex. Nowadays many organisations rely on vast networks of leased telecommunications services, with lines interconnected by sophisticated message and data switching computer systems in order to move the volume of data needed to conduct their business activities, and these services are now beginning to reach right into the home.

Present day leased telecommunications services came into being because of customer demand, and because expansion of world trade in goods and services often required 'instant' communications. It is unlikely that manufacturing industries would have spread to the developing countries without companies having the almost instant ability to control activities such as production output, arrangement of shipments and maintenance of their database information. Similarly, Off-shore Banking could not operate on its present scale if the instant communications services did not exist.

Like it or not, world trade is conducted through a nervous system of its own - known as the international telecommunications network. Cut the telecommunications services, or reduce their efficiency, and international trade would become virtually paralysed. The quickest way for a post-industrial, or an industrialised country to revert to an agricultural economy would be to take away its national and international telecommunications capability.

REGULATORY ISSUES AND THE USERS

If we consider the present range of international telecommunications services, it is interesting to note that many of the advances in modern telecommunications have been brought about by users demanding innovation from the equipment manufacturers and communications suppliers. However, without the freedom to connect the equipment resulting from manufacturers' creativity, users would find it difficult to use their own inventiveness to provide services which they believe will help give them a competitive edge in their particular industry, and to better service their customers' demands.

It is not all that many years ago that the maximum modem speed available from A T & T was 1200 bits/second, and the maximum number of telegraph channels which could be derived from multiplexed International voice circuit was only 22. That was before entrepreneurs emerged to produce a range of modems which made available line transmission speeds up to 9600 bits/second - and still rising - and Multiplexors which extended the number of derived telegraph channels from 22 to well over 100.

Innovative advances were mainly user driven; it was rare for a telecommunications administration to push technology at the user end because most of their tariffs were based on duration (where users paid by the minute), or bit rate based (where users paid by circuit speed). The only tariffed bandwidth-based facility was the voice channel, which was as cheap to lease at 9600 bps as at 300 bps.

The administrations themselves were busy providing

the fundamental international network infrastructure of satellites and cable systems. They were unchallenged in the maintenance of their monopoly of telecommunications services. Users may not have liked the monopoly environment, but the decision to operate a monopoly is a political decision which users accepted where it existed.

Business users of international telecommunications services do indeed recognize the benefit of some essential level of regulatory control governing the use and development of telecommunications. It is difficult to imagine what sort of chaos would exist if organisations such as CCITT did not exist for setting Technical and International Telecommunications standards for the basic, fundamental telecommunications services.

However, regulatory control and monopoly operation must not necessarily be considered to be synonymous. Where monopoly authority and operation is necessary, its scope should not be allowed to expand unquestioned into new areas of telecommunications innovation - and its operations should, at all times, measure up to stringent standards of performance, including fair pricing.

With technology advancing at its present tremendous pace, and if new advances in telecommunications services are not to be stifled, there must be regulatory supervision regarding the degree of monopoly permitted to any organisation providing the fundamental services. To some telecommunications administrations, technological advances do mean greater monopoly control - but users expect to see such advances giving greater facility, greater efficiency, greater emphasis on modernised facilities with increased capacity, and on the introduction of new services, particularly for data transmission.

Without regulatory supervision many of what are considered freely marketable Value Added Services in some countries may become monopoly services in other countries, and there is a good argument for stating that the level of monopoly of telecommunications administrations should not extend significantly - and certainly not unquestioned - beyond the basic national and international telecommunications infrastructure providing services to the public. Some administrations may not always have adequate financial, technical and human resources to be able to provide new and Value Added services in a timely manner, nor have all the trained resources necessary to provide effective maintenance. Those administrations may be in danger of dissipating what scarce resources they have so that they become 'Jacks of all Trades and masters of none'!

Most telecommunications administrations are government departments and subject to the constraints of national budgets. The capital costs of expansion of their services has to be financed from government funds - usually government borrowing - or through raising tariffs. Funds are needed for all aspects of government,

and it is frequently politically expedient to put telecommunications down at the bottom of the list when budgets are drawn up. As for tariffs, there is a limit to the amount the tariffs can be raised if users are not to feel like the bridegroom at a shotgun wedding. Nevertheless, Telecommunications Services providers have got to be nimble enough to react innovatively to the new and varied telecommunications needs of users without discrimination, or their users must be allowed to find other ways of satisfying their telecommunications requirements - this implies allowing users to attach suitable equipment to the fundamental network when it is necessary to do so.

In some countries restrictions are often imposed by Telecommunications Administrations - designed to favour local manufacturers - upon equipment which is not manufactured in the particular country of the Administration. Technical specifications are written in such a manner that only manufacturers in that particular country can profitably manufacture some equipment. Perhaps it is time for such administrations and their major national equipment manufacturers - especially in developed countries - to get off this 'collusion' course when it comes to setting national standards - there are already enough trade and tariff barriers in the telecommunications industry.

Users must have the freedom to 'plug in' to national and international networks on a non-discriminatory basis - always provided it is not detrimental to well defined national interests - and, from a technical standpoint, provided it does not impair the integrity of the network.

INTERNATIONAL INFORMATION FLOW

Following the right to 'plug in', the next most important user requirement is the need to create and maintain the freest possible environment for the responsible transfer of information across national boundaries. Regulations which inhibit the movement of information are barriers to trade, and the potential for these 'invisible' non-tariff trade barriers and restrictions is more acute and immediate in the area of telecommunications than perhaps in any other area. Barriers are being raised in some countries, usually based upon legitimate concerns about sovereignty, jurisdiction, confidentiality and the economic and cultural ramifications of international information flow.

Users must obviously respect legitimate National interests, but at the same time governments must seek the views of users - and user groups - in the development of policies, both at National and International levels.

It must be appreciated that information and information services are commodities, and that policies governing the transfer of information across national boundaries are therefore trade issues. The possibility that non-tariff trade barriers may be erected in countries which are

understandably anxious about questions of confidentiality and the economic consequences of unconstrained information exchange requires that any such laws or regulations to safeguard national interests be prudently framed. Otherwise, international economic activities will be stifled by unnecessary restrictions, excessive overheads and official involvement that is troublesome to government and business alike. Business users therefore support efforts to create and maintain the freest possible environment for the responsible transfer of information across national boundaries, and the setting up of international guidelines (such as the Council of Europe Convention on Data Protection) to harmonize the parameters between which data can flow freely.

THE ROLE OF THE PACIFIC TELECOMMUNICATIONS COUNCIL

PTC must become one of the vehicles which allow cooperation and discussion among public authorities, private operators, suppliers, manufacturers and telecommunications users. Users have been described as 'the fourth side of the telecommunications square' with governments, PTTs and manufacturers making up the first three sides. That is one way to look at it, but without the users, there is no 'square', there is no telecommunications industry.

Users are the marketplace, and the principles of marketing require the market place to be consulted before the introduction of new products or services - or before significant changes are made to those products or services already existing. Any supplier who launches a product which has to search for a market is unlikely to enjoy any rapid success, and frequently goes through the painful experience of an extended loss making period, losses which any other products that particular supplier may be marketing will have to bear.

Among the users of international telecommunications in most countries, there is often a large group of business users who are not only happy to discuss their business telecommunications needs with suppliers, but also are the same organisations who usually provide the major proportion of existing revenues to those suppliers. Frequently such users have invested a significant amount of their money, materials and manpower into establishing telecommunications networks especially adapted to their individual business operational needs, using tariffed services, and in accordance with any National and International regulations which may exist. Using creative and innovative ideas, these users are then able to provide new and competitive services to their customers as they determine a demand for such services exists.

Therefore the role of the Pacific Telecommunications Council as a forum for discussing the regulatory and trade issues affecting telecommunications services must be developed, and PTC must take the initiative in ensuring that the importance of the user contribution to telecom-

munications development in the Pacific region is recognized by all members. It is quite possible that the low numbers of PTC business user members is a direct indication, or reflection, of a failure to recognise - so far - the importance of users to the telecommunications industry in the region. PTC Seminars (for instance) should always include the views of the users as well as governments, administrations and manufacturers.

CONCLUSION

The formation of Business User groups in the Pacific Basin countries must be encouraged in order to provide a meaningful interface to governments and administrations and to participate in forums like PTC.

Governments must actively seek out the users' views of the telecommunications regulatory environment in each country. The growth of each telecommunications monopoly must be subject to political scrutiny and regulatory control.

Most of all, an environment for the free movement of information between the countries must be allowed to develop - free from artificial barriers.

SATELLITE COMMUNICATIONS FOR THE PACIFIC ISLANDS:
AN ALTERNATIVE TO ISOLATION

Jane N. Hurd
Public Service Satellite Consortium
Washington, D.C.*

The Pacific island governments seek solution to their telecommunications requirements. A request for assistance was issued in 1980, and since then, several studies have been undertaken by specialists from technologically advanced countries such as the United States, Japan, Australia and New Zealand. This paper briefly reviews these studies, the recent interest of INTELSAT and the reasons why solutions to Pacific islands communications problems are likely to attract the interest of still other nations and international bodies. A rationale for the continued concern of the United States government and also of the private, commercial sector is also given.

A Call for Opportunity

In a spring, 1982, meeting which explained United States participation in the upcoming Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE '82), to be convened in Vienna in August of 1982, a NASA representative made it clear that the United States was willing to offer **opportunity rather than charity** to the developing nations of the world.

Several contentious issues exist between the United States and the so-called Group of 77, the non-aligned countries in the United Nations who frequently vote against the United States. Among these issues are: (1) What legally constituted body has the authority to assign orbital slots and frequencies for direct broadcast satellite? (2) Does the United States have the responsibility to continue to make available land remote sensed data for such purposes as crop assessment, water-resource management and mineral exploration? (3) What are the rights of nations who are "sensed" to information accumulated about them? (4) Do equatorial nations have the right to control the portion of the geo-stationary orbit directly above them?

During debate on the draft of the UNISPACE '82 report, the United States objected to the inclusion of paragraphs that said that developing countries should work with one another rather than technologically developed nations. The U.S. argued that those nations should take advantage of the resources and skills available in the United States (software, hardware, expertise). Although the language was changed, it is unfortunate that, after arguing for the change in the paragraphs, the United States appeared to be ill-equipped to initiate any offers which would signal to the developing world our willingness to be cooperative and helpful.

While highly distressed by the United States refusal to sign the Law of the Sea Treaty, the sovereign Pacific Island nations have not strongly aligned themselves with the stands taken by the Group of 77. None of these island governments has claimed sovereignty to the portion of the geostationary orbit which sits directly above them. Neither have any of them insisted that, as "sensed nations," they should have the right to priority information gathered by technological powers.

Pacific Island Governments Seek Solutions to Telecommunications Needs

Government leaders in the Pacific islands have been discussing the inadequacy of communications in the region ever since the 1971 founding meeting of the South Pacific Forum -- the annual meeting of Pacific island prime ministers and those from Australia and New Zealand. Recognizing the economic necessity of telecommunications development to the region, in 1972, the governments requested and received technical and financial assistance from the International Telecommunications Union (ITU). In 1973, the Forum established the South Pacific Bureau for Economic Cooperation (SPEC), as its secretariat, and charged SPEC with assisting in the coordination of the development of regional telecommunications. Progress was steady, and within a decade, nearly every Pacific island nation had established international satellite links using INTELSAT.

At the 1980 Forum meeting, the Prime Ministers discussed the need for improved rural telecommunications and directed SPEC to advise potential satellite space segment providers (including those in Australia, the United States, Japan, and the European Economic Community) that the Pacific island countries would be interested in sharing space segment.

International Interest

The United States response included the "Pacific Basin Communication Study" which was funded by the National Aeronautics and Space Administration (NASA), and the National Telecommunications and Information Administration (NTIA) of the U.S. Department of Commerce. That study, completed by the Public Service Satellite Consortium, was widely discussed at this meeting last year. NASA, which enjoys an enviable reputation in the Pacific where ATS-1 has provided critical and previously unavailable communications support to health, education and other community services, funded a second year's investigation by PSSC, which was completed and submitted to NASA in November, 1982. The study proposes means of augmenting and improving existing systems, meeting the costs involved in increasing service to rural areas, and examines economic growth prospects for the region as a result of improved telecommunications services.

Meanwhile, a SPEC-sponsored study, "The Rural Telecommunications Study of the South Pacific," was completed by a team of telecommunications engineers from Australia and New Zealand in September, 1982, and presented at SPEC's annual telecommunications meeting later last fall on the island of Niue.

It is anticipated that, because both studies recommend the expansion of telecommunications services through the use of satellites, the design-specific orientation of the SPEC study and the broader infrastructure planning effort by PSSC will provide complementary information which will assist island nations telecommunications authorities in planning. The reports should also make available to Pacific island governments information upon which they can base imminent decisions at the highest level of government.

INTELSAT has expressed increasing interest in the telecommunications needs of the Pacific islands. In 1982, a new tariff for multi-point to multi-point international audio teleconferencing for education, particularly for possible application by the University of the South Pacific, was approved by the INTELSAT Board of Governors. FINTEL, the INTELSAT signatory from Fiji is coordinating with other Pacific island INTELSAT users on the introduction of this new service which most likely will be initiated only after the cessation of a reliable signal from the seemingly indefatigable ATS-1. Presently, there seems to be little motivation to phase in the INTELSAT service for which users will have to pay, even though the initiation of the new service would free-up ATS-1 to provide basic

communications service to currently unserved remote areas of the Pacific.

INTELSAT has been encouraging the development of low-cost earth stations to be used with INTELSAT satellites. But, because INTELSAT's global satellite system carries two-thirds of the world's overseas traffic on primarily high density routes between and among large countries, the INTELSAT system has consisted of satellites with relatively low power and broad geographical coverage that work in coordination with powerful, expensive and complex earth stations. Until now, INTELSAT has not viewed thin-route service as a high priority, and progress on developing earth stations appropriate for the Pacific and other remote underserved small populations has been slow. There are plans to introduce a service into the Pacific using current INTELSAT space segment which would permit small (3 to 4.5 meter) earth stations to be located on the outlying islands, provided there is a large earth station (7 to 13 meters) at some connecting location. For a small station to speak to a small station, the signal would have to travel through the satellite to the nodal station and then back up through the satellite a second time before it reached the second small station. This double hopping would require additional satellite capacity and, of course, the use of the expensive connecting or nodal station such as the INTELSAT Standard B antenna.

Evidence of other major space powers' interest in the telecommunications needs of the Pacific island nations came at PTC '82, with the announcement that the Japanese Research Institute for Telecommunications and Economics (RITE) would undertake a study of satellite usage in the Pacific. SPEC was officially notified of that decision by the Japanese Ministry of Posts and Telecommunications early in 1982. Clearly, the Japanese see this market not necessarily revenue producing, but as entree to the pursuit of other economic goals, e.g., commercial fisheries, raw materials, long term investments and political sphere of influence.

Although Papua New Guinea is the only Pacific island nation to gain access to the first generation of the Australian domestic satellite (AUSSAT), the Prime Minister of Australia has stated that the needs of the Pacific islands will be taken into consideration in the planning of the second generation of AUSSAT.

Most Pacific studies have investigated the possibility of using retired satellites from the first generation of the Indonesian PALAPA series (PALAPA A), once PALAPA B is in service. These require large antennas on the ground. There have been indications that Indonesia has

expressed interest in providing service to some Pacific island nations. Many difficulties are typically associated with such plans. Often the footprints are unsuitable for the area requiring service, the satellites have inadequate remaining design life, or leasing arrangements would imply a dependency which Pacific island nations may be unwilling to accept.

The Soviets are providing international telecommunications in direct competition to INTELSAT in Algeria, Nicaragua and Cuba as well as to the Soviet-bloc nations of eastern Europe. It may be interesting to note that, while there has been no public expression of interest in assisting the Pacific islands in meeting their telecommunications requirements, seven Soviet satellite systems may be operational over the Pacific Ocean in the 1980's.

A Unique Alternative Emerges

Perhaps the most controversial option to have emerged since the call for assistance by the Pacific island Prime Ministers has been the possible use of the Western-most satellite of the Tracking and Data Relay Satellite System (TDRSS), a series of 4 to 10 geostationary satellites to be launched beginning in 1983 by the United States. While the primary mission of this shuttle-launched system is to track low orbiting satellites and the shuttle itself, it is now probable that the part of the system which was to be used for commercial purposes, Advanced Westar, will not be used. NASA seeks to regain control of all capacity on the system through negotiations with SPACECOM, the owner of the system. Those interested in the use of TDRS/171 for the Pacific postulate that by inhibiting the complete deployment of the C-band antenna, the spacecraft's beam could be repositioned to a mode that would provide coverage of the Pacific islands without interfering with the spacecraft's primary mission.

As presently configured, the twelve C-band transponders of TDRS/171 will remain idle and surplus. If the C-band antenna were reconfigured and made available to the Pacific island nations, the needs of nearly every Pacific island country south of the equator and east of Papua New Guinea could be accommodated. Because of the transmitted power of the satellite, earth stations with very small apertures (3 to 6 meter) could be used.

Although official response from NASA (where the idea was deemed not technically impossible, but "impractical") and the Department of State to requests from SPEC for access to TDRS/171 has been negative, this example provides an

opportunity for reassessing the position taken by the United States as to whether or not it should make available to developing nations unused space capacity.

Benefits That Would Accrue

The Pacific island nations have expressed a willingness to pay for access to the space segment they seek. They would also assume responsibility for the ground segment and for replacement costs. The nations' request for assistance was not a bid for charity; it was, rather, a request for an opportunity which they were willing to arrange to fund.

A positive gesture to the Pacific island nations--a follow-on to ATS-1 which could be used for widespread commercial and public service--would signal to the third world as a whole that the United States addresses the needs of the developing world. It would strengthen the United States' position among her allies in the Pacific, and it would signal to the Soviet Union (whose submarines are making an increasing number of incursions into Pacific waters) and others that the use of space remains an integrated part of United States foreign policy objectives particularly in terms of civilian applications worldwide.

Besides the economic gains that would come with assisting in the implementation of a telecommunications system compatible with a U.S. satellite, (the ground stations and the tracking, telemetry and control,) such U.S. economic interests in the Pacific as commercial fishing would likely also be protected. Political gains would also accrue. The long term political assets of such a positive gesture as making space segment available to the Pacific islands would also go a long way to offset the cost to the United States government, and would alter considerably the image of the United States in a friendly area of the world which demonstrates increasing participation in United Nations fora where the one-country one-vote principle applies.

*This paper is based primarily on information from the "Pacific Basin Communications Study" which was undertaken by the Public Service Satellite Consortium, Washington, D.C., under contract with NASA, and managed by Ms. Hurd. Since completing this work, Ms. Hurd has been a contractor with the Office of Technology Assessment, United States Congress, Washington, D.C.

Telematic Infrastructures
For The Developing Pacific

Professor Neil Dias Karunaratne
Head, Economics
The University of the South Pacific
Suva, Fiji

Abstract

The Pacific Island Nations face the prospect of leap-frogging into an information era from a mere subsistence economy. The current development planning strategies echo the revealed preferences of the islanders. The planning strategies aim at improving the material welfare by catering for basic needs. The infrastructure programming strategies have glossed over the potential of telematics (telecommunications and computers). Telematics is a cost effective and timely basic needs delivery mechanism. Such infrastructures would also promote trade, industrialisation and regional economic co-operation. Priority for telematic infrastructure programming over other infrastructure is strongly recommended.

1.1 FROM SUBSISTENCE AFFLUENCE TO THE
INFORMATION ERA

For many centuries the Pacific Island Nations (PINs) thrived as affluent subsistence economies. The colonisation of the island economies witnessed the spread of modern transportation and telecommunication to exploit the islands' resources for the benefit of the metropolitan powers. Roadways, shipping and later on aviation functioned as capillaries to extract mineral, plantation and other raw materials to feed metropolitan processing and also market finished products in the peripheral economies. However, the period of decolonization heralded the emergence of development planning institutions with the avowed aims of improving the lot of indigenous peoples by pursuing strategies of self-reliance and economic diversification. These planning strategies envisaged the restructuring of narrow and vulnerable colonial plantation and mineral economic bases by expanding agriculture and by instituting import substitution and export-oriented industries.

The colonial economy was essentially dualistic leaving out of its purview the welfare of the majority (about 80%) of the 5 million people that inhabited the rural hinterland of the Pacific states. This rural populace eked out a subsistence life. Although Pacific subsistence economy differed from the poverty stricken subsistence economies of Afro-Asian regions it remained, nonetheless, stagnant, trapped in a vicious circle or low level equilibrium of material welfare from which growing numbers of rural folk sought an

escape in order to enjoy a higher standard of material welfare.

Today planners in PINs, as in most other developing economies, are attempting to implement development strategies that will eventually enable their economies to achieve self-sustained growth after graduating through various stages of agricultural and industrial development.

These planning strategies are based on massive capital intensive infrastructural inputs: roads, harbours, airports and social overheads such as schools, hospitals and government office complexes. But even before these new developments can achieve the hoped for results a new wave of technological change has catalysed the world economy and posed a new obstacle to the economic ambitions of the PINs.

Many metropolitan economies of the world have rapidly crossed the threshold of the post-industrial economy and emerged as information economies. In an information economy *information* becomes the engine of growth not the 'raw muscle power, or energy' that had characterized the industrial society (4). The critical input of the new growth function is telecommunication infrastructures and computers, or *telematics*. Telematic infrastructures play the same cardinal role in the information economy that various transportation modalities played in the industrial economy. Unfortunately there is no evidence that development planners either in the PINs or in other developing countries have really acknowledged the potential of new telematic infrastructures

to achieve optimal economic development. Much of the recent development planning literature on the Pacific islands is engrossed in the diseconomies inflicted by the size of islands, their isolation, susceptibility to natural hazards and remoteness from metropolitan markets (1), (2).

The global information and telematic revolution, together with the prospects it offers to catapult scattered and isolated subsistence island economies into a post-industrial or information era has been largely ignored. Telematics in advanced economies are rendering obsolete traditional financial infrastructures, news media, postal services and retailing methods. Telematics are acting as the common medium for new uses. 'Function and form are converging, driven by the convergence of technologies. Their enterprises are on a collision course: The infrastructures of electronic funds transfer, electronic publishing, and electronic mail services are essentially identical' (14). Also, new technology is rapidly replacing non-information capital and labour by informatics (telecommunications and computers) and information workers with the result that centres of power have shifted from technocrats and industrial magnates to new information elites. Therefore, it is not unlikely that in the PINs, hereditary chiefs and the landed and ecclesiastical oligarchies will feel disturbed by the challenge such impending changes might have on their authority. Either by design or by default the promise of telematics may not be harnessed for some time to come. New prospects must be carefully researched and tapped if the PINs are not to pay a heavy price for procrastination and the continued misallocation of scarce resources to obsolete and ineffective infrastructures.

2.1 THE TRAUMA OF RAPID INFORMATIZATION AND PRAGMATISM

It is obvious that leap-frogging from a subsistence economy to a modern information era will be resisted by those vested interests whose powers and privileges are threatened. Nevertheless, the technological determinism of the global informatization process is bound to unfold a new cornucopia and a Pandora's box for the people in the island economies. If the adoption of new-technologies or telematic infrastructures can over-compensate the losers by taxing the beneficiaries there is a strong welfarist rationale for introducing the new infrastructures. The new infrastructures may be appropriate, enhancing the quality of rural life, and

may contribute significantly to the achievement of rapid self-reliance. Therefore, the backlash from entrenched power groups or from those institutions committed to the preservation of the status quo should be challenged and their qualms allayed.

The new telematics infrastructure is only one facet of a wider scenario of change that will engulf the PINs. The social fabric of the island nations is already changing kaleidoscopically at the grass-root level. The indigenous 'dalo' and 'taro' cultures of yesteryear are rapidly being replaced by imported tin fish, coke and hamburgers, blue jeans and disco music. The changed preferences of islanders for new consumption patterns are increasingly reflected in the ever widening balance of payments deficits. Even more dramatically the massive rural-urban drift and rising numbers of emigrants demonstrate that the rank and file are voting with their feet for a modern affluent life style. To many the surge of modernisation may appear to be a curse. But to thwart it by using countervailing powers or even by a cultural revolution in the 'open' island economies may be dysfunctional or counter productive. Change and modernisation, however loathsome to traditional elites and institutions, is desirable if it benefits the vast majority of the underprivileged people in the islands.

PIN planners, willy-nilly or by sheer pragmatic foresight, have encapsulated the revealed preferences of the islanders for higher material welfare in their planning targetry and objective functions. They have also tempered their development targetry by a strong thrust to achieve self-reliance. The ensuing process of change will be traumatic to some segments of the community. In this context the most one could expect is to humanize the face of modernization by the infusion of 'measures of social justice, political participation and cultural intensification' (18). These sentiments are echoed in contemporary Pacific development planning. However, the major serious flaw in Pacific island planning is its failure so far to develop a clear perspective on the benefit-costs of informatization or adoption of telematics. In this new information age small open economies can effect huge cost savings on conventional infrastructural outlays if they plug into the spreading 'wired society' or 'planetary culture' with only a marginal cost to the developing economy.

3.1 INFRASTRUCTURE COSTS AND THE COMPARATIVE ADVANTAGE OF TELEMATICS

In contemporary development planning strategies, conventional infrastructures such as roading, shipping, aviation are geared firstly to meet the transportation and communication needs of a widening and diversified or developing economic base. Secondly, and particularly in the context of the PINs, these conventional infrastructures purport to deliver effectively a range of basic needs such as education, health care, emergency services, extension services, to the rural hinterland and outer islands. However, escalating energy and other input costs of conventional infrastructures are rapidly pricing those facilities out of the reach of PINs' capital budgets. For instance, in Tonga the cost of bitumen for road surfacing rose by 40% in 9 months in 1980. The average annual price escalation for infrastructures during the period of the first Tongan development plan (DP IV) was 15% (9). In the arena of shipping, the rapid introduction of larger vessels, containerization and the need for modern cargo handling installations are operating to the detriment of intra-island trade and shipping in the PINs. The staple copra export of many island economies such as Tuvalu has suffered a sharp decline due to the new trends of shipping and the disappearance of the small cutter boats (5, 15). The trend towards wide-bodied jets have required huge investments for upgrading runways and other airport facilities. Competition, excess carrying capacity have led to high airfares and freight charges. The soaring costs and specificity of conventional transportation infrastructures stand in sharp contrast to the increasing comparative advantage and flexibility of telematic infrastructures.

Information storage and processing costs have dropped by more than ten-thousand-fold over the past two decades without any loss of speed or efficiency in retrieval or transmission. The leaps in micro-processor technology (the 'chip-revolution') offer fantastic reductions in the costs of telematic operation and installation. These plummeting cost trends indicate that towards the turn of the century a Fijian using a small US\$250 dish antenna from the roof-top of his village *bure* (house) could receive advice on health and education as well as 12 channel colour TV (3).

Cost reductions in telematic infrastructures are important if one considers that substantial amounts of the total development planning budgets are earmarked for the provision of transportation

infrastructure and social overheads for basic needs delivery. In the latest Fiji development plan (1981-85) 49% of a total budget of F\$1540 is apportioned for infrastructure and basic needs delivery (8). The latest Tongan development plan commits 45% of its total development budget for similar purposes (10). It should be noted that these investments are lumpy and have protracted gestation lags. Moreover, there is some evidence that they benefit only small urban and rich segments of the populace. Therefore, rethinking on conventional infrastructural issues is opportune and perhaps imperative if basic needs and self-reliance oriented development planning is to reach the masses and transcend the realm of rhetoric and pseudo-planning. In Fiji during the previous plans: DP6 and DP7, nearly 80% of the capital budget on infrastructure development was used up by the capital city-international airport link, the Suva-Nadi highway. This type of conventional infrastructural development, which commits a large chunk of scarce capital resources to one project, exacerbates vicious dualism and runs against the articulated objectives of development planning in the PINs. Telematics on the other hand has the potential of being able to diffuse widely its services in a shorter time.

There is ample evidence both from the Pacific region and elsewhere that there are more attractive alternatives to conventional infrastructures. The success of RCA-SATCOM satellite telecommunications for basic needs delivery to isolated and scattered Eskimo settlements in the Arctic, the deployment of ATSl satellite to combat a cholera epidemic in Kiribati, the successful Radio Mathematics project in Nicaragua, and the University of the South Pacific educational extension services (11) are all milestones which demonstrate clearly some of the uses and benefits of cost-effective and relatively maintenance free appropriate infrastructural telematics for the Pacific islands.

4.1 TELEMATIC INFRASTRUCTURE OPTIMIZATION AND CONSTRAINTS

The allocation of scarce resources to lumpy infrastructures that accentuate vicious dualism or social polarisation is obnoxious because it eventually retards long-term growth. In some countries government subsidised basic needs delivery, using conventional infrastructure, has led to an expensive trade-off in growth (12). The dictates of allocation as well as distributional efficiency reinforced by the prospect of favouring the deprived current rural generations make prioritization

zation of telematics over conventional infrastructures optimal in the case of the island economies.

But this exuberant advocacy of telematics over conventional infrastructures should not be construed to mean that telematics and telecommunications can substitute for all transportation and travel. Interactions between telematics and transportation occur at least in three forms: substitution, stimulation and modification. Telematics in a basic needs delivery strategy could replace substantial amounts of business and social trips. In developed economies it is estimated that teleconferencing and home telematics could replace 60% of business and office work generated travel (6). In rural Lincolnshire most of social and non-information activity associated with non-business trips which accounted for 27% of total travel was deemed to be substitutable by telecommunication (16). While teleconferencing and telemedicine can substitute only for some of the basic needs provision and could result in spectacular cost savings, they cannot replace altogether surgical or therapeutic treatment or provide through broadcasting the laboratory experiments required for science education. Also the availability of telematics will stimulate the demand for conventional infrastructure because telematics by spurring economic activity will make transportation a binding constraint on further progress. Besides, there is much scope for modification and innovation in travel patterns by the application of telematics. Unfortunately such new possibilities are yet unexplored in the context of developing economies.

The new telematics, which can give access to a modicum of basic needs to isolated Pacific settlements through direct broadcasting satellites (DBS), can also open the flood gates of 'cultural imperialism'. For instance, it can inculcate the spirit of cut-throat competition for profit maximization and completely undermine the co-operative ethics of *kere-kere* (communal sharing). But yesterday's cultural practices may in any case be an anathema today. Recently, the indigenous populace in Fiji thoroughly resented the flippant cannibal quote by the Australian Broadcasting Corporation's Four Corners program. This also had a decisive influence on the outcome of the last general election in Fiji. What is central in the context of articulated objectives of development planning strategies is not the preservation of culture for its own sake but whether

telematics will be able to make a significant improvement in the quality of life of a generation of village folk who otherwise may by conventional approaches, never have access to any form of modern basic needs in their life time.

5.1 TELEMATICS AND INTRA-REGIONAL TRADE CO-OPERATION

Telematics not only enhances the prospects of basic needs delivery but also stimulates the growth of key sectors of an economy. Trade, tourism, fisheries, mining, industry - all perform more efficiently with access to good telematics. A two-way relationship exists between infrastructure and economic activity. Development planning strategies of PINs designed to achieve take-off to self-sustained growth must provide the appropriate infrastructures, otherwise the economy may remain stagnant or grounded.

In the field of trade a strong symbiotic link prevails between trade and telecommunication traffic. In PINs, due to the colonial legacy trade and telecommunication flows are predominantly oriented towards metropolitan interests. Restructuring these colonial configurations of trade and telecommunications is imperative if PINs are to break away from being hewers of raw materials and drawers of finished products. Currently 93% of PINs trade occurs with metropolitan economies and exports are mainly minerals and agricultural raw materials. Intra-regional trade amongst the PINs is only a small fraction of total trade (3%). A similar picture can be observed in telecommunication traffic flows.

The PINs can restructure the hegemonic trade and telecommunication patterns only by regional economic co-operation. The expressed political will of PINs to integrate regionally is a powerful force that can be harnessed to achieve the collective self-reliance goals announced in development plans. Telematics can play a crucial role in forging the regional economic bonds. Also telematics can provide the lever to promote greater intra-regional trade and industrial development.

Recent reports are pessimistic about the prospects of successful trade liberalization and industrialization amongst the PINs. It has been argued that in the absence of complementarities, and large resource endowments, regional free trade has a bleak future. Moreover, any move towards free trade it is asserted will favour the larger economies

such as Papua New Guinea and Fiji at the expense of the smaller economies. Smaller economies would suffer trade diversion, loss of revenue due to reduction of import duties, and demise of nascent industries due to severe competition from the larger PINs (7).

Notwithstanding the apologia for preservation of the status quo embodied in these normative prescriptions the PINs should push for regional economic co-operation in trade and telematics. The cavalier dismissal in these studies of intra-regional trading prospects without proper appraisal of industrial possibilities both for import substitution and export promotion needs to be questioned. The failure of trading arrangements in Latin America and East Africa does not support the conclusion that trade liberalization amongst PINs is doomed to failure. The PINs could by economic co-operation pool their markets, scarce resources, bargaining power, and infrastructures to overcome the impediments of small economic size, high transport costs and lack of large resource endowments. The trade co-operation efforts of ASEAN (Association of South East Asian Nations) wherein industries are identified on complementarity and 'package deal' grounds to cater for regional and international markets indicate that export-oriented regional economic co-operation is feasible (13). But in the contemporary global scenario of rising neo-protectionism, the repetition of the miracles of NICs (New Industrialized Countries) by PINs is doubtful. PINs should aim at a strategy of balanced economic growth by regional economic co-ordination and co-operation on a wide range of activities. Telematics will be a king-pin in such co-ordination and co-operation strategies to achieve economic independence and balanced growth. Unless PINs 'gain control of their economic destinies via production of capital goods and income elastic exports, their dependent status is certain to persist' (17). Telematics more than any other form of infrastructure will enable PINs to realize their own potential through regional co-operation and thus eliminate the external noise that breed division and undermines the momentum towards regional cohesion.

6.1 THE NEED TO PLAN FOR THE SATELLITE OPTION

The benefits telematic infrastructure offer to developing PINs have been identified, albeit in a qualitative manner. The capital costs of telematics although competitive compared to conventional infrastructures, nevertheless are

burdensome for a single PIN. A regional approach to share the cost of the space segment of the telematics and manage it on behalf of the island economies is a logical solution. Recent cost estimates by the PSSC (Public Service Satellite Consortium) indicate that US\$205 million will be required to orbit an S-band satellite (with a spare) and establish about 3000 small earth station (19). The PSSC's Integrated Satellite Communication system can easily dovetail into existing terrestrial communication networks and also offer scope for future expansion.

Several modalities have been proposed to manage and program the space-segments of the integrated regional telematic network: a single country management on behalf of other PINs; a private corporation or a regional consortium either building on an existing regional organisation such as SPEC or on an entirely new footing. In view of the high level skills and manpower required for the installation of the satellite system, it may be prudent to invite private foreign investor participation. Since telecommunications investments in developing economies have reported satisfactory internal rates of return, averaging 18% (20), attracting foreign participation may not be problematic. Collaboration with foreign private investors will also facilitate financing and spreading the risks of investing in new technology. However, by astute bargaining the PINs should maintain the controlling power in any management contract with private foreign investors. The success of bargaining depends on the expertise and knowledge the spokesmen for PINs have in negotiating management contracts on telematic infrastructures. In view of the over riding importance of telematic infrastructures for the development of PINs national planners should co-ordinate their expertise and prepare to negotiate with prospective investors so as to clinch the best deal for the region. Procrastination on regional telematic expansion will act as a drag on the development of PINs individually and collectively.

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Satellite Communications for Public Service in the Pacific Basin:
Policy, Institutional and Infrastructure Issues

Arthur L. Levine
Professor, Department of Public Administration
Baruch College, CUNY
Box 336, 17 Lexington Avenue
New York, New York 10010

Abstract

A regional satellite system for the Pacific Basin would be a major part of a new telecommunications initiative to meet public service and rural needs. These needs may go unmet, however, unless serious policy, institutional and infrastructure issues and constraints are addressed. This will require specific action by national and regional leaders.

I. INTRODUCTION

The need for improved telecommunications in the Pacific Basin has been established.¹ It is generally agreed that satellite communications should make up a major part of a new telecommunications effort. There is also general agreement on the desirability of a regional satellite system to serve the Pacific Basin. Throughout the discussions of the need for improved telecommunications, the importance of serving public service needs and providing access to rural users has been stressed. A prime justification of a regional satellite system is the promise it brings for improvements in health care delivery, disaster preparedness and relief, education of all types, information useful to those engaged in agriculture and fishing, and social services.²

Major problems of identifying and financing appropriate space and ground segments, both for interim and long range purposes, remain to be solved. But solution of these problems will not ensure a practical, working satellite system. Serious policy, institutional and infrastructure issues must be addressed and satisfactory solutions worked through. The purpose of this paper is to explore these issues.

II. BACKGROUND

These issues should be viewed in the context of two important factors: (1) the history of telecommunications development in rural areas of developing countries in general and in the Pacific Basin in particular; (2) the political, economic and social environment of the Pacific Basin Islands.

Rural telecommunications have lagged behind those in urban areas in developing countries. The reasons have been documented and can be boiled down to the rural handicaps of lower aggregate demand, lower ability to pay and longer distances over which communications must be sent.³ The low volume, thin route character of rural communications has made it unprofitable to con-

struct terrestrial communications to serve rural needs. Thus, there has been a tendency to emphasize commercial and urban uses of new telecommunications systems in developing countries. MacDonald, Mandeville and Lamberton point out that this tendency may even widen the gap between telecommunications services available to urban and rural users. They cite the recent case study by Neil Karunaratne of telecommunications in Papua New Guinea (PNG) as a model of the consequences of heavy commercial interest in the telecommunications services of a developing country.⁴ With World Bank aid in the early seventies, PNG modernized and revamped the interurban trunk routes connecting the copper mine, plantations and centers of government administration. Using modern technology, eight towns with populations over 12,500 were linked to a main switching center. Most impressive of all, though, is PNG's excellent external communications links with her main trading partners. Thus, PNG now has an efficient telecommunications system for those with interests overseas and in her eight main cities. However, 86% of PNG's population is rural and, as Karunaratne puts it, is 'bereft of any modern telecommunications'. It would appear that the main impact of modern telecommunications technology in PNG has been to reinforce the existing dualistic pattern of development.

'If this has been a consequence of pressure from commercial users of new telecommunications technology, similar consequences may be expected when those users are also the suppliers of the new telecommunications technology. When information is a commodity vital to the survival of business and when that business is not only the main user of the means by which information is stored, processed and transmitted, but also the main supplier of those means, there are grounds for doubt that priority concern will be for the provision of basic telephone services in the rural hinterlands of developing countries in the Pacific Region.'⁴

A. Impact of a Satellite System

A satellite system would remove the handicap of

the large distances involved. In addition, ground equipment may be easier to put in place and to maintain than equipment normally used with terrestrial networks. But the factors of low aggregate demand and low ability to pay on behalf of rural users remain. Thus, in order to obtain financing of a satellite system which serves rural users, it may be necessary to opt for a system which is shared among commercial, urban and rural users, with emphasis on those users which can generate the most income. In that case, the pattern of telecommunications development outlined above could assert itself.

The political, economic and social environment of the Pacific Basin Islands appear to present difficulties to the realization of a practical, working satellite system which services public service and rural needs. There is a great diversity of political, economic and social interests among the Pacific Basin Nations and within the larger nations. Some of the smaller nations are reported to feel that they have been left out of the decisionmaking process of existing regional organizations.⁵ In some nations, rural communities are at odds with central governments, according to recent studies.⁶ The Pacific Basin Islands have little wealth and little expertise in telecommunications. They would be working with developed countries and international organizations for the financing, design, construction and implementation of a regional satellite system. Since the process for building and implementing a new satellite system is lengthy, such close cooperation would extend over a period of many years. This situation may arouse fears of dependency and may aggravate the divisions and strains mentioned above. In addition, there is concern that a satellite system could bring a heavy dose of commercial broadcasting, including TV. This may consist mainly of imported programming, of which a large share would probably be programs produced by commercial networks in the U.S. Such a development is seen by some observers as endangering traditional cultural values of the peoples of the Pacific Islands.⁷

This combination of factors could well work to stymie agreement among the Pacific Basin Island nations on the basic purposes and elements of a shared regional satellite system. This in turn might open up opportunities for commercial interests to press for an interim system that meets existing and near-term needs for business and urban applications while controversies over the long range system are settled. The nature of an interim system would probably have a profound influence on the character of the long range system.

A counterweight to the potential factors for division and disagreement is the strong and growing sense of regional cooperation among the Pacific Basin Islands, along with a significant mutual desire to work together for telecommunications improvement for public service and rural needs. The challenge is to find means of capitalizing on this cooperative impetus while easing the divisions, strains and fears outlined above.

III. ANALYSIS

A. Impact of History and Environment

1. Policy

What does this history and these environmental factors imply for the policy, institutional and infrastructure issues? On the policy level, there appears to be a danger that, unless special measures are taken, the policy process could be dominated by commercial and bureaucratic interests which may not be sensitive to the needs of public service and rural users. In an effort to assure financing and to generate international and regional support for a satellite system, companies and governmental authorities interested in using the system for urban and business communications may argue successfully that a new system should be shared among urban, commercial, and rural users, with emphasis on those uses which would generate maximum income. While their intentions in making sure that a satellite system becomes a reality would be laudable, the result could be a system that provides little capacity to reach rural areas and little access for rural users. The initial policy decisions with regard to the overall nature of the system would shape subsequent decisions on the types of ground equipment, interconnections and even programming.

2. Institutional

Even if the policy process includes emphasis on public service and rural user needs, institutional arrangements and approaches for implementing the satellite system may not be well suited to protect public service and rural user needs. The organizational arrangements for managing the system are crucial in this regard. The study of the Public Service Satellite Consortium (PSSC) suggests four options for the managing entity.⁸ These are: (1) a single country would be the manager and other countries would purchase telecommunications capacity from this "manager country"; (2) creation of a new private company or corporation in which participating countries would be partners; (3) creation of a new consortium that would act on behalf of member countries; (4) designation of an existing regional body, probably the South Pacific Bureau for Economic Cooperation (SPEC) as the manager. Each of these options has potential drawbacks for insuring that the needs of public service and rural users are met.

The PSSC study discusses some advantages and disadvantages of each option, but does not stress which option would be preferable from the standpoint of public service and rural users. The single manager country may not be a good option in this regard because such an arrangement could aggravate the diversities and rivalries discussed earlier. If this option is chosen, serious consideration must be given as to how rivalries and misunderstandings can be avoided or minimized. A private corporation may become so concerned with

economic returns and its balance sheet that it may feel impelled to make operational decisions based on their impact on the "bottom line." This could exclude initiatives which would benefit public service and rural programs. At the same time, a corporation might evolve toward being autonomous of regional control as it develops a life of its own buttressed by close ties to non-regional investors.

A new consortium would, as the PSSC study indicates, be difficult to set up, entailing a long and cumbersome ratification period. Once in operation, decisionmaking may be complicated by the diversities and divisions discussed earlier. Further, the consortium is less likely to have borrowing power than would a corporation. On the other hand, a consortium would have the advantage from the public service and rural user standpoint of insuring that the diverse interests of member countries (including their rural communities) would be continuously represented. Further, as a regional satellite organization, the consortium would be likely to be a strong advocate for improvements in the system of benefit to public service and rural needs.

The fourth option--using an existing regional body, such as SPEC, has the advantage of building upon a viable regional structure which would help obtain financing and political support. It also has the advantage of an existing forum for participation by countries in the region. To run the satellite system, SPEC would have to create a division or separate authority. Would such an entity be able to develop a strong management and monitoring capability if it were subjected to close hierarchical and budget control? General purpose consortia often have difficulty in developing strong subsidiaries for managing specialized activities. This problem might be solved by the creation of an authority with a large degree of managerial and budgetary leeway. In such a case, the authority may tend toward independence, thus curtailing the advantage of regional participation and control. The history of public authorities suggests that such an outcome is not unlikely.⁹

The choice of an appropriate managing entity would not obviate historical and environmental factors which may influence the technical design and day-to-day management of the satellite system. In view of the lack of expertise for these tasks in the Pacific Basin Islands, they would be performed largely by firms or individuals from developing nations. In the past, there have been instances in which the technical design and project management of satellite systems did not show sensitivity to basic considerations of cost, maintenance and user ability. These are vital to successful day-to-day delivery of rural telecommunications. As Parker has pointed out:

"A factor in the technical design of many satellite systems is the fact that satellite engineers tend to design on the basis of average cost, while system users make their utilization decisions on the basis of marginal cost. The economists and

marketing people in satellite companies may understand that distinction well, but they may not understand satellite system engineering enough to insist on different engineering design as a consequence. For example, satellite engineers may design systems to achieve the least cost per bit transmitted on the average. The result is likely to be a system appropriate for the very small number of locations needing more than six million bits per second of data transmission. That kind of system will be too expensive for all but the few large corporations with data transmission requirements approaching six million bits per second. Such a system is not affordable at the large number of locations where a smaller data communication requirement exists. Similarly in voice telephony, low average costs can be achieved when a group of 12,000 voice circuits is needed at the same place. But such a system has no market in communities where far fewer circuits are required. Satellite engineers have seldom addressed the problem of finding the least marginal cost for providing one voice telephone or one 30 character per second data channel, even though their corporate marketing department could tell them there are more locations with smaller requirements than with larger.

"Another factor in the technical design of satellite systems is that satellite engineers usually assume the task of optimizing the distribution of costs between space segment and earth segment, as if the number of earth station locations were a predetermined number to be paid for by the organization paying for the space segment. In most satellite systems, both assumptions of that widespread engineering practice are false. The entity offering the space segment service (e.g., Intelsat for international service, RCA or Western Union for U.S. domestic service) is seldom the entity supplying the earth stations.

"The market for the space segment is dependent on users paying for earth stations. The number of such earth stations to be purchased by many different users cannot be accurately predicted in advance. To make the space segment economically viable a large number of potential users must have marginal investment costs small enough to induce them to make the earth station investment decision.

"The marketing department could tell the engineering department to engineer the system for least marginal cost earth stations in order to induce more people to use the system. But the engineers will usually resist because such strategies, while they are rational to economists and marketing people, appear irrational to engineers. The engineers are steeped in trade-off analyses based on known numbers of locations and average costs. In the real world, the number of locations is unknown in advance, and is a function of the marginal cost of adding earth stations. Each additional earth station added to a system helps defray some of the fixed cost of the satellite, thereby making the economics of the entire system more attractive. Unfortunately, few engineers understand that type of marginal cost analysis. The people who do may

not be in a position to intrude on what engineers consider to be their domain. Unfortunately average cost engineering analyses discriminate against potential rural users."¹⁰

Over-emphasis on certain elements of the project management approach--particularly those dealing with meeting milestones for hardware installation--may also result in lack of sensitivity to rural user needs. As Korten points out:

"Projects by nature deal with time bounded start-up costs and emphasize facilities and equipment to the neglect of the development of the fundamental capacities of their sustained operation and maintenance....Furthermore (project organization) virtually assures that the real decisions will remain with professional technicians and government bureaucrats neither of whom are rewarded for being responsive to local conditions nor contributing toward the development of local institutional capacities."¹¹

IV. SUGGESTED MEASURES

A. Policy

The policy problems identified cannot be solved by general statements in enabling documents, or assurances, no matter how sincere, that public service and rural user needs will be met. Specific provisions must be incorporated which state explicitly that public service and rural needs are given high priority. Such provisions should be backed up by specific objectives, such as the minimum number of telephones per remote community, the establishment of a specific number of message centers in a rural area, or the allocation of minimum number of hours for broadcasting of programs with a public service or rural user orientation. Specific provision for arrangements for representation of public service and rural users on decisionmaking and advisory committee bodies should be made, especially for those processes in which allocations and other decisions affecting capacity and access are made. Policy statements should include provisions with regard to system design and management which insure user input. Participation by users in mid-project decisions which affect access should also be assured.

B. Institutional

The choice of a management entity should take into account the values of continuous participation by member countries in the decisions affecting public service and rural capacity and access. With appropriate structure and control mechanisms, this probably can be done with any of the four options outlined in the PSSC study. It appears that a new satellite consortium would be a good vehicle for achieving these purposes, but it has major drawbacks with regard to start up time and potential ability to attract financing. Building upon an existing regional structure, therefore, may be the most practical alternative. An existing regional body already has mechanisms for participation of member countries. Attention

must be paid, however, to devices for insuring representation of public service and rural users and for adequate control of the division or authority that manages the satellite operation.

The design and project management issues discussed earlier can be addressed in part by provisions for including local managerial and technical personnel in the preliminary project phases as well as during construction and implementation. Input from community user groups should be arranged at periodic intervals through scheduled review meetings.

C. Infrastructure

The deficiencies identified would be more readily remedied if a policy and institutional framework sensitive to public service and rural needs is in place. But infrastructure problems in telecommunications parallel those in other development areas, as the PSSC study points out. These problems are part of the broader development picture. To build an appropriate telecommunications infrastructure it will be necessary to coordinate and integrate efforts of designers, managers and implementers with those of the various ministries responsible for substantive programs (such as education, agriculture, health, etc.) and with telecommunications authorities. It is important to use local talent and locally available materials for installation and maintenance, since this bolsters local competence for taking over operation of the system in the long run. A systematic program for training local personnel is also essential.

Beyond these specific activities, an awareness is needed of what is actually going on in rural areas as planning for and installation of satellite systems proceeds. As Hornik points out "Communication projects make assumptions about what is true in the environment of their intended beneficiaries which may be at substantial geographical and cultural distance from the projects' sponsors and staff. Because of that distance, it is likely that these assumptions are wrong, either in general or in detail. Communications projects need to know what is going well and what is not. They need efficient data gathering mechanisms and, no less important, time and flexibility within their operational structure to define the information which can be used, and to take full advantage of the information that is gathered."¹²

To assume that a satellite system can be superimposed on the Pacific Basin without tailoring it to internal dynamics of the nations involved is to risk having an underutilized and unappreciated technological showpiece. The success of telecommunications in playing new roles in developing countries "depends largely on the ripeness of the circumstances and commitments of other segments of the society."¹³

V. CONCLUSION

A satellite system for the Pacific Basin region

is an exciting and enticing prospect. Its potential for serving public service and rural user needs is great. Regional leaders have recognized the need and the potential and are rising to meet the challenges of making a system a reality. In addition to fashioning a grand design and building a foundation for launching the new system, leaders should also be prepared to confront the myriad policy, institutional and infrastructure issues and constraints which a new system will encounter. The problems associated with these issues and constraints can be solved if they are identified and specific measures are taken to deal with them.

NOTES

1. The nations and jurisdictions of the Pacific Basin include American Samoa, the Cooks, Fiji, French Polynesia, Guam, Kiribati, Nauru, New Caledonia, Niue, Papua New Guinea, the Solomon Islands, the Tokelaus, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands, and Western Samoa. The Trust Territory of the Pacific Islands, once the compact terminating the Trusteeship has been signed, approved by Congress, and reconfirmed by plebescite, will result in four separate entities: the Republic of Belau, the Commonwealth of the Northern Marianas, the Marshall Islands and the Federated States of Micronesia, which include the States of Yap, Truk, Ponape, and Kosrae.
2. For a discussion of the need for improved telecommunications see International Telecommunications Union, Development of Telecommunications in the South Pacific. (Suva: Fiji: UNDP/ITU, 1981; project report for starting date Jan. 1, 1982).
3. For a discussion of these reasons see Edwin Parker. "Communication Satellites for Rural Development," Telecommunications Policy (March, 1981), pp. 12-17.
4. S. MacDonald, T. Mandeville and D. Lamberton, "Telecommunications in the Pacific Region," Telecommunications Policy (December, 1981), p. 250.
5. Elizabeth L. Young and Jane N. Hurd, Pacific Basin Communications Study (Washington, D.C.: Public Service Satellite Consortium, 1981), pp. 56-57; (hereafter referred to as PSSC Study). This is a comprehensive study of the subject, with especially valuable sections on telecommunications and the management of human and economic resources, and the potential gains from a regional satellite system.
6. PSSC Study, pp. 38-43.
7. This view was elaborated during a presentation by Carlos Boker in a panel on "Satellite Communications for Public Service in the Pacific." National Conference, American Society for Public Administration, Honolulu, Hawaii, March 22, 1982.
8. PSSC Study, pp. 192-99.
9. Annemarie H. Walsh, The Public's Business (New York: Twentieth Century Fund, 1979); MacDonald, Mandeville and Lamberton, op. cit.
10. Parker, op. cit., pp. 14-15.
11. David C. Korten, "Community Organization and Rural Development: A Learning Process Approach," Public Administration Review (Sept./Oct. 1980), p. 484.
12. Robert Hornik, "Communication as Complement in Development," Journal of Communication (Spring, 1980), p. 20.
13. Ibid., p. 10.

PARAMETRIC APPROACH TO THIN-ROUTE EARTH STATION REQUIREMENTS

Raymond D. Jennings and Peter M. McManamon
U. S. Department of Commerce
National Telecommunications and Information Administration
Institute for Telecommunication Sciences
Boulder, Colorado

1. Abstract

Satellite communications are likely to be used to provide thin-route telephone service in the Pacific Basin and developing countries only if the cost of earth stations can be substantially reduced. A parametric analysis of earth station design and service capabilities is presented. Both INTELSAT and domestic satellites are considered for the space facility.

2. INTRODUCTION

Satellite technology is well suited for providing communications to users that are remotely located and at locations that are widely separated. The costs for installing and using satellite-based technology are independent, to a considerable degree, of distances between remote and widely dispersed locations. In some areas such as the Pacific Basin, alternative technologies are not feasible between islands (e.g., microwave radio), or are not cost feasible between islands (e.g., undersea cable), or are limited in service and performance (e.g., HF radio).

A significant and important cost consideration to satellite communications being utilized by remotely located and widely separated users is the installed costs of earth stations for remote locations. Repair and operational maintenance requirements also are critical because of the limited accessibility of the earth-station site. This paper discusses estimated costs for earth stations, F.O.B. manufacturers' plants as unassembled components.

At present, and for the next several years, the best suited satellite capabilities available for lease to serve thin-route requirements for basic communication services operate in the 6/4 GHz bands (5.925-6.425 GHz for earth to space transmission and 3.700-4.200 GHz for space to earth transmission). The cost of leasing transponder bandwidth also will influence decisions to utilize satellite communications. These costs are discussed in other documents [1,2,3] and therefore not addressed by this paper. While the 14/12 GHz band development is well underway, this paper will be concerned with the 6/4 GHz bands.

The Agency for International Development (A.I.D.), U.S. Department of State, has embarked on a multi-year program to help develop satellite communications suited to establishing basic, reliable communication systems in rural and developing areas of the world. The program cooperates with selected countries in projects to demonstrate the usefulness of these technologies applied to providing basic health, agricultural, and educational services to rural populations. This paper reflects

part of the results developed for A.I.D. towards their program goals.

3. SATELLITE TRANSPONDER BANDWIDTH RESOURCES

The INTELSAT practices leasing "spare" transponder capacity on its operational satellites to member nations for the development of domestic communications [1]. There are at least 16 nations with domestic communications using INTELSAT (IV or IV-A) leased transponder capacity [2]. Resources for lease also are available on operational INTELSAT V satellites [3]. The minimum capacity that can be leased is 9 MHz (1/4 of a 36 MHz transponder.)

Rural satellite program applications in the area of Indonesia may be expanded using Palapa System satellites. The Palapa satellites' technical characteristics are typical for many domestic satellite systems such as ANIK, WESTAR, SATCOM, and COMSTAR.

Technical characteristics of the INTELSAT IV, INTELSAT IV-A, and Palapa transponders are given in Table 1.

Three examples of the relationships between earth station networking, offered service, and the type of satellite transponder to support the service, all of which influence earth station costs, are presented in the discussion of earth station characteristics. Two examples deal with use of the INTELSAT global beam as found on the IV and IV-A satellites. The third example assumes a Palapa-type satellite. In all cases, 1/4 of a 36 MHz transponder is assumed for the space lease bandwidth.

4. NETWORK CONSIDERATIONS

Communications may be established in either a STAR or MESH network of earth stations with as few as two earth stations.

STAR networks are considered as one or more remote earth stations (which have limited capability and capacity) each linked only with a central master earth station. In these analyses, the central earth station usually is assumed to be an INTELSAT Standard B station or one of

Table 1. INTELSAT IV and IV-A and Palapa Transponder Nominal Technical Characteristics

Beam Coverage of Satellite Antenna	<u>INTELSAT IV and IV-A*</u>		<u>INTELSAT IV-A*</u>		<u>Palapa **</u>		
	Global		Hemispheric		Shaped for Indonesia (Palapa A) Shaped for Indonesia, Philippines, and Thailand (Palapa B)		
Satellite G/T (dB/K)	-18.6		-11.6		-7.0 (Palapa A) -5.0 (Palapa B)		
Transponder Leased Resources Characteristics	Flux Density (Receiving)	EIRP (Transmitting)	Flux Density (Receiving)	EIRP (Transmitting)	Flux Density (Receiving)	EIRP (Transmitting)	
						Palapa A	Palapa B
Saturation	-67.5 dBW/m ²	22.0 dBW	-67.5 dBW/m ²	26.0 dBW	-80.0 dBW/m ²	32.0 dBW	34.0 dBW
Back-off Required for Multiple Carriers	-10.5 dB	-4.5 dB	-11.0 dB	-6.0 dB	-7.0 dB	-4.0 dB	-4.0 dB
Multiple-Carrier Operation, 36 MHz	-78.0 dBW/m ²	17.5 dBW	-78.5 dBW/m ²	20.0 dBW	-87.0 dBW/m ²	28.0 dBW	30.0 dBW
Multiple-Carrier Operation, 9 MHz	-84.0 dBW/m ²	11.5 dBW	-84.5 dBW/m ²	14.0 dBW	-93.0 dBW/m ²	22.0 dBW	24.0 dBW
Number of Transponders per Satellite	12 (INTELSAT IV) 20 (INTELSAT IV-A)		20		12 (Palapa A) 24 (Palapa B)		
Transponder Bandwidth (MHz)	36		36		36		

*Reference [1].

**References [4,5].

equivalent capability. (The second example in this paper is an exception.) STAR networks offer restricted connectivity, since circuits can be established only between the central earth station and each of the remote earth stations. Remote-to-remote connections must be relayed through the central station.

MESH networks are formed by two or more earth stations, each capable of linking directly with every other station in the network. The earth stations in a MESH network are assumed to have identical technical characteristics. Full connectivity may be achieved in a MESH network.

5. EARTH STATION CHARACTERISTICS

The circuit C/N (carrier power-to-noise power density ratio) which is required as a function of the type of modulation used to provide voice service is the basis (in conjunction with technical characteristics of the transponder which is used) for establishing characteristics of the earth station. Toll quality voice using conventional SCPC-FM (single channel per carrier, frequency modulation) requires the C/N to be about 54 to 57 dB-Hz. In these studies it has been assumed that satisfactory voice quality can be provided using CVSD (continuously variable slope delta modulation) voice encoding at 20 kilobits per second (kbps) with FEC (forward error correction) coding at rates $R = 3/4$ or $R = 1/2$ to reduce the bit error rate (BER) and phase shift keying for rf modulation at C/N ranging from 47.5 to 51.2 dB-Hz, depending on the FEC coding rate and/or operating margin included.

The C/N realized in an application is controlled by the satellite EIRP (equivalent isotropically radiated power) for some given bandwidth (usually, the bandwidth assigned to each transponder), the number of channels provided in that bandwidth, and the G/T (antenna gain-to-noise temperature ratio) of the receive earth station, which sometimes is referred to as the figure of merit of the receiving system. The G/T is determined by the gain of the antenna at the receive frequency, primarily a function of the antenna size (or aperture) and the noise temperature of the receiving system which is controlled largely by the noise temperature of the LNA (low noise amplifier). Increasing satellite EIRP or the earth station receive gain or decreasing the receive system noise temperature will increase the C/N of the received signal. And, increasing the number of circuits in some given transponder bandwidth will decrease the C/N of the received signal.

Satellite EIRP is determined by gain of the satellite transponder, gains of the satellite antennas, and uplink PFD (power flux density) of the signal received by the satellite. That uplink PFD is controlled by gain of the transmitting earth station antenna and power delivered to the antenna by the HPA (high power amplifier). (Of course, propagation losses and miscellaneous other losses

which cannot be controlled also must be taken into account.) Satellite EIRP can be increased by increasing transponder gain or the PFD of the signal received by the satellite. Power flux density can be increased by increasing the transmit gain of the earth station antenna or power provided by the HPA. Selection of the earth station antenna size based on desired receive system characteristics essentially determines the gain that will be available for transmit applications. Therefore, the parameters among which design tradeoffs can be considered are required C/N, size of the antenna (which determines receive gain), noise temperature of the earth station LNA, gain of the satellite transponder, power provided in uplink signals by the earth station HPA, and the number of circuits provided in some given segment of transponder bandwidth (which corresponds to a given quantity of satellite EIRP).

For basic communication services (telephony) such as those considered here, each thin-route earth station is considered to provide a capability of 1 or 2 full duplex voice circuits. Larger capacities significantly increase the cost and usually require evidence of sufficient, available, offered traffic. If traffic develops at a later date, increased capacity can be obtained through suitable modifications to the earth station.

Example 1. The most challenging situation arises from plans to use an INTELSAT satellite with global beam coverage and standard transponder gain. An example of minimum capability service, i.e., SCPC and one channel per earth station, is shown in Table 2 by the first eight rows (first two sets of rows) of information.

Column by column, the table shows antenna size and noise temperature of the LNA followed by the receiving system figure of merit (G/T) which will be realized. System noise temperature is assumed to be the amplifier noise temperature plus 35 K. Then, the HPA requirements, the number of circuits per 1/4 transponder (9 MHz), and estimated earth station component costs are shown for MESH and STAR network applications respectively. It should be noted that the HPA power requirements shown and the estimated costs are based on providing SCPC service with one duplex voice circuit per earth station.

The first four rows of information are for systems with FEC coding (redundancy) at rate $R = 3/4$. The second four rows of information portray applications using FEC coding at rate $R = 1/2$. (A similar pattern is followed for the applications using high transponder gain.) In the third row, it is shown that a 4.5-m diameter antenna will provide G/T = 22.5 dB-Hz when used with an LNA with noise temperature of 90 K. The HPA must provide 42 W in a MESH network, whereas only 6 W are required in a STAR network. Twenty-two duplex circuits would be available in a MESH network; thirty-nine circuits would be available in a STAR network. Finally, the estimated earth station component costs aggregated, are \$58,200 for a

Table 2. Tabulation of Antenna Size, LNA Noise Temperature, HPA Output Power, the Number of Circuits (Using One Channel per Carrier), and the Estimated Cost of Earth Station Components When the Satellite Resource is 1/4 Transponder on an INTELSAT Global Beam Coverage Satellite and Voice Encoding is Performed at 20 kbps

Ant. Size (m)	LNA Temp. (K)	G/T (dB/K)	HPA Power (W)		No. of Circuits per 1/4 Transponder		Earth Station Cost (\$ X 1000)	
			MESH	STAR	MESH	STAR	MESH	STAR
---Standard Transponder Gain, FEC* at R = 3/4 (Required C/N _o = 49.2 dB-Hz)---								
3.0	140	17.5	290	12	7	13	73.0	53.0
4.5	190	20.0	73	6	12	23	65.4	49.8
4.5	90	22.5	42	6	22	39	58.2	50.6
6.0	90	25.0	14	3	39	64	83.7	77.3
---Standard Transponder Gain, FEC* at R = 1/2 (Required C/N _o = 47.5 dB-Hz)---								
3.0	140	17.5	195	8	10	20	72.0	48.0
4.5	190	20.0	49	3.6	19	35	62.4	49.2
4.5	90	22.5	29	3.6	33	58	56.2	50.0
6.0	90	25.0	9	2	58	95	78.9	76.8
---High Transponder Gain, FEC* at R = 3/4 (Required C/N _o = 49.2 dB-Hz)---								
3.0	140	17.5	53	2.6	7	13	59.0	46.4
4.5	190	20.0	14	1.1	12	23	55.4	47.9
4.5	90	22.5	8	1.1	21	37	51.2	48.7
6.0	90	25.0	2.5	0.6	37	60	77.1	75.9
---High Transponder Gain, FEC* at R = 1/2 (Required C/N _o = 47.5 dB-Hz)---								
3.0	140	17.5	36	1.7	10	19	53.0	46.0
4.5	190	20.0	9	0.8	18	34	50.6	47.8
4.5	90	22.5	5	0.8	32	56	51.0	48.6
6.0	90	25.0	1.7	0.4	56	88	76.7	75.8

*FEC denotes Forward Error Correction Coding (at rate R = 3/4 or R = 1/2).

MESH network earth station and \$50,600 for a STAR network earth station. Row 7 (in Table 2) shows the respective reductions in required HPA power and estimated earth station costs with corresponding increase in circuit capacities provided by 9 MHz when FEC coding at rate R = 1/2 (greater redundancy) is used.

For comparison, the second two sets of rows of information in Table 2 are based on global beam coverage with high transponder gain which is 7.5 dB more gain than the standard gain. The high transponder gain reduces, substantially, the required power from the HPA, but it does not increase the capacity (number of duplex circuits provided by 1/4 transponder). In fact, the communications capacity of 1/4 transponder decreases slightly due to increase in the required satellite EIRP per carrier to provide a slightly higher downlink C/N_o to achieve the required system C/N_o. However, the reductions in required HPA capabilities do reduce the estimated earth station costs for respective G/T and required C/N_o values shown in the lower half of Table 2 when compared with estimated costs for earth stations capable of operating with use of standard transponder gain.

Example 2. Results for another example are shown in Table 3. A STAR network is assumed with two,

full duplex voice, SCPC circuits provided by each remote earth station. (The central earth station is assumed to use a 7-m antenna and LNA with noise temperature of 80 K. Consistent with these assumptions, the figure of merit (G/T) will be 26.6 dB/K.) Using digital voice encoding, FEC coding, and QPSK (quadrature phase shift keying) rf modulation, C/N_o of 49.2 dB-Hz will provide corrected BER = 1×10^{-4} for the signal; C/N_o of 51.2 dB-Hz allows a 2-dB operating margin. The receive system figure of merit (G/T) is 23.1 dB/K, using a 5.0-m diameter antenna and LNA with noise temperature of 100 K (system noise temperature is assumed to be 135 K).

Low operating levels (2.4 to 3.8W) for the HPA are possible due to the use of digital technology to reduce the required C/N (compared with required C/N_o not less than 54 dB-Hz for SCPC-FM, for example) and the use of high transponder gain. These low HPA power levels reduce the burden on primary power requirements, particularly important if solar primary power sources are used. Up to 34 circuits are possible with satellite EIRP apportioned to 1/4 transponder compared with only 11 circuits per 1/4 transponder if SCPC-FM technology were used.

Table 3. Earth Station Characteristics and Estimated Costs for the Remote Terminal, STAR Network Using 1/4 Transponder (High Gain) on an INTELSAT Global Beam Coverage Satellite, Providing Two Circuits per Earth Station Using SCPC-CVSD at 20 kbps (and SCPC-FM for Comparison)

	$C/N_0 = 49.2 \text{ dB-Hz}$ (No Margin)	$C/N_0 = 51.2 \text{ dB-Hz}$ (2 dB Margin)	$C/N_0 = 54 \text{ dB-Hz}$ (SCPC-FM)
Antenna Diameter (m)	5.0	5.0	5.0
G/T (dB/K)	23.1	23.1	23.1
LNA Noise Temperature (K)	100	100	100
HPA Output Power per Channel (W)*	2.4	3.8	7.2
Circuits per 1/4 Transponder	34	21	11
Earth Station Components Costs**	\$61,300	\$62,500	\$81,000

*Two HPA's, each operating at saturation, are assumed.
**Circulator and shelter are not included.

The aggregated cost of the remote earth station components is estimated to be \$61,300 to \$62,500, nearly \$20,000 less than for an earth station using SCPC-FM technology to provide two SCPC channels per earth station.

Example 3. System implementations to meet given service requirements are easier to satisfy when

using a domestic satellite such as a Palapa B, rather than an INTELSAT global coverage satellite. Principal technical characteristics, service that can be provided, and estimated earth station costs for an example using 3.0-m antennas, MESH networking, and SCPC-CVSD at 20 kbps to provide two duplex telephone circuits per earth station are summarized in Table 4.

Table 4. Earth Station Characteristics and Estimated Costs for the Remote Terminal, MESH Network Using 1/4 Transponder on a Palapa B Satellite, Providing Two Circuits per Earth Station Using SCPC-CVSD at 20 kbps

	$C/N_0 = 47.1 \text{ dB-Hz}^1$	$C/N_0 = 49.2 \text{ dB-Hz}^2$	$C/N_0 = 51.2 \text{ dB-Hz}^3$
Antenna Diameter (m)	3.0	3.0	3.0
G/T (dB/K)	17.5	17.5	17.5
LNA Noise Temperature (K)	140	140	140
HPA Output Power per Channel (W)*	1.4	2.1	3.3
Circuits per 1/4 Transponder (9 MHz)	185	125	79
Earth Station Components Costs**	\$50,800	\$55,400	\$56,400

*Two HPA's, each operating at saturation, are assumed.
**Circulator and shelter are not included.

¹CVSD at 20 kbps with $R = 1/2$ FEC coding and no operating margin.

²CVSD at 20 kbps with $R = 3/4$ FEC coding and no operating margin or $R = 1/2$ FEC coding and 1.7 dB operating margin.

³CVSD at 20 kbps with $R = 3/4$ FEC coding and 2 dB operating margin.

Several observations should be noted. With the digital voice encoding, FEC coding and QPSK modulation are used. The C/N of 47.5 dB-Hz is suitable when FEC coding at rate $R = 1/2$ is used and no operating margin is allowed. Error correction coding at rate $R = 3/4$ requires the C/N to be 49.2 dB-Hz, with no operating margin. Allowing an operating margin of 2 dB, service with rate $R = 1/2$ FEC coding will require 49.5 dB-Hz, and 51.2 dB-Hz will be required at rate $R = 3/4$ FEC coding. The three columns of Table 4 cover these four options. (The second column for $C/N_0 = 49.2$ dB-Hz applies directly to applications using FEC coding at rate $R = 3/4$ with no margin, and applications using FEC coding at rate $R = 1/2$ would have 1.7 dB margin.)

Current technology in GaAs FET (field effect transistor) low noise amplifier design and manufacturing is such that use of LNA's with 140 K noise temperature likely would not be an economically and technically prudent design choice. The values shown in Table 4 simply arise by following the parametric approach to earth station design which is emphasized by this paper and an earlier report [6]. An earth station design to use LNA's with noise temperature in the 85 K to 100 K range would improve significantly the receive system figure of merit (G/T); increased cost would be negligible. Use of LNA's with 90 K noise temperature (assumed receiving system noise temperature of 125 K) and 3.0-m antennas would result in G/T = 19.0 dB/K, rather than 17.5 dB/K as used in Table 4, an improvement of 1.5 dB.

The power amplifiers used in earth stations for this application clearly should be GaAs FET rather than TWT (traveling wave tube) amplifiers. Use of the solid state amplifiers would reduce the earth station cost, reduce environmental control requirements on the earth station hardware thus further reducing total earth station costs, and improve the earth station reliability.

7. CONCLUSIONS

Satellite technology, though well suited for communications to remote and widely separated locations (thin-route applications), will be utilized for such applications only if earth station costs can be reduced substantially. Digital voice encoding and related digital technology offer a way to reduce the earth station cost. This study assumes satisfactory voice quality is realized using CVSD voice encoding at a sampling rate of 20 kbps. That rate is used with FEC coding, to achieve decoded bit error rates not exceeding 1×10^{-4} , and QPSK modulation in a parametric approach to earth station design. The use of these digital techniques helps reduce earth station costs because lower required carrier power-to-noise power densities are possible than when using conventional SCPC-FM, i.e., 47.5 to 49.5 dB-Hz rather than 54.0 to 57.0 dB-Hz.

Utilization of satellite technology for thin-route applications will also depend heavily, at least initially, on leased satellite resources, assumed to operate in the 6/4 GHz bands. Such resources can be provided by INTELSAT or owners of domestic systems such as the Palapa system. Technical characteristics of INTELSAT and Palapa transponder resources (at 6/4 GHz) are summarized while noting the minimum bandwidth assumed to be available under lease arrangements is 9 MHz (1/4 of a 36-MHz transponder).

The merits and restrictions for MESH and STAR networks of earth stations are reviewed briefly. Within the context of available transponder resources for lease and the network options just mentioned, parametric results are given to illustrate the tradeoffs that can be considered in an earth station design (i.e., antenna size, receiving system noise temperature which primarily is dependent on the noise temperature of the LNA, and power requirements of the HPA) in relationship to estimated earth station costs when the digital technology described earlier is applied.

The most stringent design condition assumes MESH networking and use of an INTELSAT IV or IV-A satellite with global beam coverage and standard transponder gain. Table 2 shows that unassembled earth station components with a 4.5-m antenna would cost an estimated \$56,200 to provide one circuit per earth station. Unassembled earth station components with a 6.0-m antenna would cost an estimated \$78,900. The EIRP for 1/4 transponder will support 33 circuits if the 4.5-m antennas are used or 58 circuits with use of 6.0-m antennas.

The least stringent design condition for MESH networking assumes use of a domestic satellite like a Palapa B. Table 4 shows that earth stations with 3.0-m antennas would have an unassembled component cost between \$50,800 and \$56,400 with capability for two circuits per earth station, depending on the amount of redundancy used in the FEC coding and the operating margin desired. These costs reduce by \$10,000-12,000 if only a single circuit is provided by the earth station. The satellite EIRP for 9 MHz bandwidth will support 79 to 185 circuits, again depending on selected FEC coding rates and operating margins.

For thin-route applications (one or two telephone circuits per earth station), the digital technology described by this paper offers attractive reductions in earth station cost while providing minimum satisfactory voice quality. The likelihood of MESH networking avoids the requirement for an expensive central earth station that would be required in a STAR network.

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System Configurations and Applications
in Domestic/Regional Satellite Communications

Kenji Yoda and Yuhei Ugai
Nippon Electric Co., Ltd.
Tokyo, Japan

1. Abstract

Satellite communications systems have been increasingly expanding their application as one of the most effective means of setting up a domestic/regional telecommunications network. Possible configurations and applications will be reviewed, and key factors to be taken into considerations in the course of system planning and design will be highlighted. A method of assessing investment efficiency will also be examined, as part of the system optimization, for management executives and/or engineering staff who are or will be in charge of domestic/regional satellite system planning.

2. INTRODUCTION

There are many alternative systems for domestic/regional telecommunications networks, and each alternative has inherent advantages and disadvantages. The increasingly expanding application of satellite communications is a direct result of its essential features which are its excellent and stable signal quality, independency of distance and geographical conditions, and high immunity from possible disruption due to natural disasters or hostilities. In order to achieve an attractive satellite communications system with all its basic features, careful examination and consideration during the system planning and design is essential. This paper is intended to review the possible configurations of satellite communications system, and also to examine the various design factors which contribute significantly to the investment efficiency, operational versatility and implementation/maintenance simplicity of the entire system.

3. SYSTEM CONFIGURATIONS AND APPLICATIONS

The Configuration of a satellite system depends primarily on the telecommunication services to be provided, and also on the spacecraft available for the system. As an introduction, some existing operational systems, some under construction and some systems currently being planned for the near future will be quickly reviewed and categorized into the various services being provided. For each category of system application, the planning or design criterion which have the most serious impact on the system efficiency will be pointed out.

3.1 TELECOMMUNICATIONS SERVICES

Satellite systems can be classified into several categories, depending upon telecommunications service to be provided, and also on the volume of information to be handled. It should be noted that in an actual system two or more services may be integrated into a single system to form a combined network, e.g., thin-route telephony and TV/radio distribution, or trunk telephony and data transmission.

3.1.1 TELEPHONY INTERCONNECTION

In most domestic satellite systems, now in operation, the major service is telephony interconnection. This category of service can further be divided into: 1) trunk interconnection and 2) thin-route rural services. The system configuration and planning/design criteria should be correctly tailored for the intended service.

(1) Trunk Telephony:

The system may in general handle a large volume of traffic between a limited number of earth stations located in urban areas. The key factor in the system design should be the choice of the multiple access and carrier modulation schemes, to optimise the satellite capacity.

(2) Thin-Route Telephony:

The most significant feature of such a system is that it has a large number of remote stations and that the traffic volume handled by each remote station is quite small. Naturally, the most significant factor in the system design is to simplify the configuration of the remote station, minimizing the initial investment and operation/maintenance expenditure for the system. Use of a single channel per carrier (SCPC) scheme with demand assignment multiple access (DAMA) technique or another appropriate means of satellite circuit concentration is essential partly to simplify the configuration of the remote station, and partly to make efficient use of the satellite capacity.

3.1.2 DATA INTERCONNECTION

This service category can be regarded as identical to the telephony interconnection, since high-speed data and low-speed data correspond respectively to trunk telephony and thin-route telephony in view of the system capacity and configuration. For this service, however, use of digital modulation is essential to optimize the modulation efficiency.

3.1.3 VIDEO/AUDIO INTERCONNECTION

Video signal interconnection for program exchange and teleconferencing are included in this category.

Since the number of earth stations in such a system are not as large as in a video distribution system or in a thin-route telephony network, the system planning/design should be oriented primarily to the function, performance and operational versatility required by the system.

(1) Program Exchange:

A straightforward transmission of the highest signal quality is an essential design criterion for the system. If a video compression technique is applied to save satellite capacity, an allowance for signal quality degradation, due to use of such a technique, should be included.

(2) Teleconference:

Optimization of transmission efficiency is of prime importance to the system design. Use of signal compression techniques, including a slow-scan and/or freeze picture, will be widely applied to the extent that the signal quality is acceptable for the intended service. Automatic change of the transmission speed from a full-motion picture to a freeze picture may be necessary in a high radio frequency system, e.g., 20/30GHz system, which is sensitive to rain attenuation.

3.1.4 VIDEO/AUDIO DISTRIBUTION

Satellite communications is very suitable for a TV signal distribution network, since the satellite itself can be regarded as a huge broadcasting antenna tower 36,000,000 meters high. Within the satellite antenna coverage an unlimited number of receive stations may be installed without any system restriction. Distribution networks can further be classified into: 1) rebroadcasting system and 2) direct reception system.

(1) Rebroadcasting:

Video/audio signal received from the satellite will be redistributed through a cable network or a broadcasting transmitter. The design criteria of receive signal quality should be a trade-off between possible degradation due to the redistribution network and a low-cost, simple receive-only station configuration.

(2) Direct Reception:

The system design criteria is quite different from that of a rebroadcasting system, in that the number of TV receive-only stations involved in the system is extremely large, and therefore the cost of the receive station should be minimized to the maximum extent possible. Use of a dedicated high power satellite is also essential for a viable system.

Table 1 SYSTEM CATEGORIES AND DESIGN CRITERIA

SYSTEM/SERVICE CATEGORIES		SYSTEM FEATURES			MAJOR DESIGN PRIORITIES		
		No. of Stations	Signal Quality	Satellite Features	Optimize Satellite Capacity	Maximize Signal Quality	Minimize Station Cost
Telephony Interconnection	Trunk Telephony	Small	High	Wideband	x	x	-
	Thin-Route Telephony	Moderate or Large	High or Moderate	High Power	-	-	x
Data Interconnection	High Speed Data	Small	High	Wideband	x	x	-
	Low Speed Data	Moderate or Large	High	Depends on System Capacity	x	-	-
Video/Audio Interconnection	Program Exchange	Small	High	Wideband	-	x	-
	Teleconference	Small or Moderate	Moderate	Depends on System Capacity	x	-	-
Video/Audio Distribution	Rebroadcasting	Large	High or Moderate	Wideband	-	-	x
	Direct Reception	Very Large	Moderate	Very High Power	-	-	x

In a summary to this section, Table 1 provides a classification of the various satellite systems, in relation to telecommunications services to be provided.

Each system category includes the key factor or factors, on which relative importance should be placed in the system planning/design.

3.2 OBJECTIVE SATELLITE

The configuration of a satellite system largely depends on the parameters of the operational satellite. In particular, the available bandwidth and down-link power are key parameters which determine the framework of the entire system, e.g., system capacity, signal quality, earth station size, etc. Consideration of the basic satellite parameters will be given for two possible cases: 1) dedicated satellite and 2) leased satellite.

3.2.1 DEDICATED SATELLITE

In this case, the satellite parameters can be tailored to a large extent for the intended system configuration. However, some limits will exist, depending partly upon cost penalty, and partly upon technical restriction. In order to determine the satellite parameters, there are various factors which are closely related to one another, and difficult to deal with indiscriminately. Here, our description is only limited to the following general criteria:

a) The geostationary orbit is a limited natural resource, and it is therefore desirable that the satellite capacity should be as great as practicable.

b) The cost or investment should be optimized for overall system and should include the ground segment cost. In this regard, it should be noted that the design life of a satellite is considerably shorter than that of an earth station, and therefore the space segment cost, due to annual depreciation, will be accordingly higher.

c) With suitable earth station parameters, the satellite RF bandwidth and down-link power can be optimized. In general, however, such technical optimization is not always consistent with cost optimization.

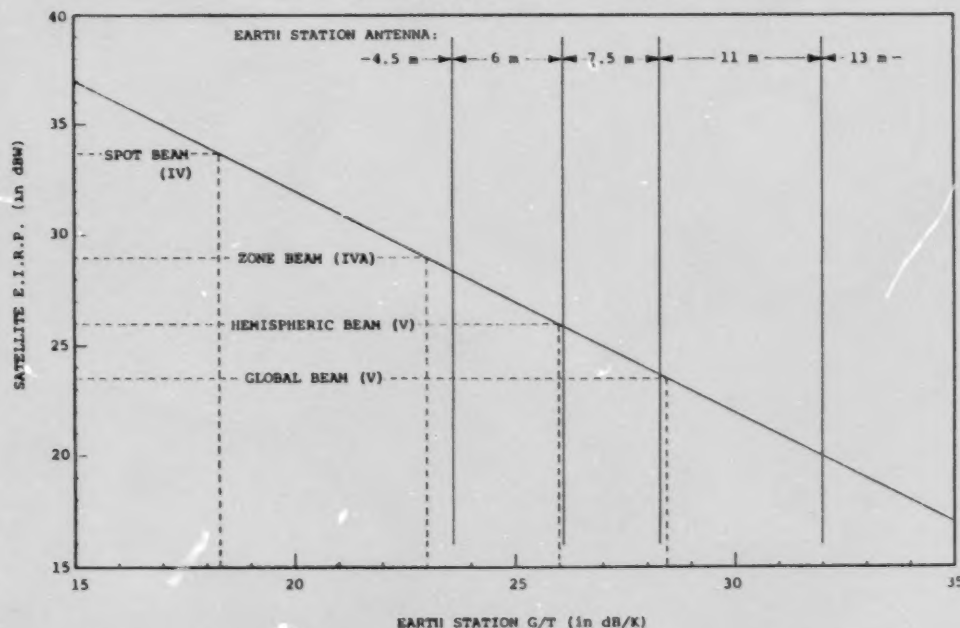
3.2.2 LEASED SATELLITE

In a satellite system which operates with an existing satellite, leasing available spare capacity, the system planning/design is naturally limited by the parameters of the satellite. For example, when only a low-power satellite is available, a TV rebroadcasting system may be feasible using a VHF/UHF low power transmitter collocated with a TVRO station. However, a TV direct reception system which may involve a large number of remote stations will not be economically viable. Within given limitations, the design should be optimized placing relative importance to the choice of transmission schemes/parameters and earth station configuration.

In general, however, a choice of satellite is still available. For INTELSAT spacecraft, there is a choice of transponders, i.e., global beam, hemispheric beam, zone beam, or spot beam.

Naturally, the higher the available down-link

Fig. 1 TRANSPONDER POWER AND EARTH STATION G/T REQUIRED
FOR TRANSMISSION OF 1200 CFM-SCPC VOICE CHANNELS



power the more expensive the transponder lease charge will be. On the other hand, the higher transponder power will allow a simpler and less expensive earth station configuration. Fig.1 indicates the relationship between available transponder power and the earth station G/T requirement, assuming that the system would have to handle 1,200 CFM-SCPC carriers using a full 36MHz transponder, and that signal-to-noise ratio at the operating point would be 50dBp companded equivalent.

The above example indicates the various alternatives and allows the planner to make the most advantageous choice taking into consideration the overall system cost. It is advisable that the system cost should be examined in terms of annual expenditure, and that the investment cost for earth station construction should be converted to an annual depreciation cost. This will be described in more detail in the next chapter.

4. SYSTEM DESIGN APPROACH

Possible configuration of domestic/regional satellite communications system have been reviewed, and the major criteria for system planning/design have been identified. This chapter is devoted mainly to description on general procedures of the system design and basic consideration on design criteria.

4.1 DESIGN OBJECTIVE

The final objective of the system planning/design should be to minimize the overall system cost. The satellite link design should maximize the system capacity, thereby minimizing the per-channel satellite cost, and also simplify the earth station configuration, thereby minimizing the ground segment cost. Once the earth station parameters have been determined, the station design should place priority on minimizing the operation and maintenance expenditure.

In general, the annual cost of a system (C) can be given by the following expression:

$$C = X + Y + Z + A \quad \dots\dots\dots (1)$$

where, X; satellite cost. In case of a leased satellite, this should be the annual lease charge, while with a dedicated satellite, an annual depreciation cost shall apply.

Y; earth station cost, in terms of annual depreciation cost.

Z; annual cost for operation and maintenance, including spare provisioning cost, electricity cost, personnel expenditure, etc.

A; general administration cost per annum.

For calculation of annual depreciation cost (D), the following formula may apply:

$$D = P \cdot \frac{i(1+i)^n}{(1+i)^n - 1} \quad \dots\dots\dots (2)$$

where, P; initial investment.

i; interest per annum

n; period of depreciation, or lifetime of the facilities to be depreciated, in years.

It should be pointed out that the cost factors, X, Y and Z, largely depend on the satellite link optimization, with regard to system capacity and earth station configuration. Another significant point is that the initial investment should be assessed as a depreciation cost. In a leased transponder system, for example, an increase in the earth station investment may sometimes improve transponder efficiency significantly, resulting in a lower operation cost for the entire system.

4.2 SYSTEM CAPACITY OPTIMIZATION

In the satellite system planning/design, one of the most essential decisions is the choice of the multiple access scheme and the carrier modulation technique which in turn depend upon the information to be carried and the number of earth stations to be interconnected. The final choice should maximize transponder capacity whilst keeping the earth station configuration as simple as possible.

For reference, Fig.2 shows the relationship between transponder capacity, in terms of the number of voice channels, and earth station capability, in terms of the station G/T, for various multiple access/carrier modulation alternatives. Use of a full INTELSAT hemispheric-beam transponder is assumed. The following general comments apply to each scheme.

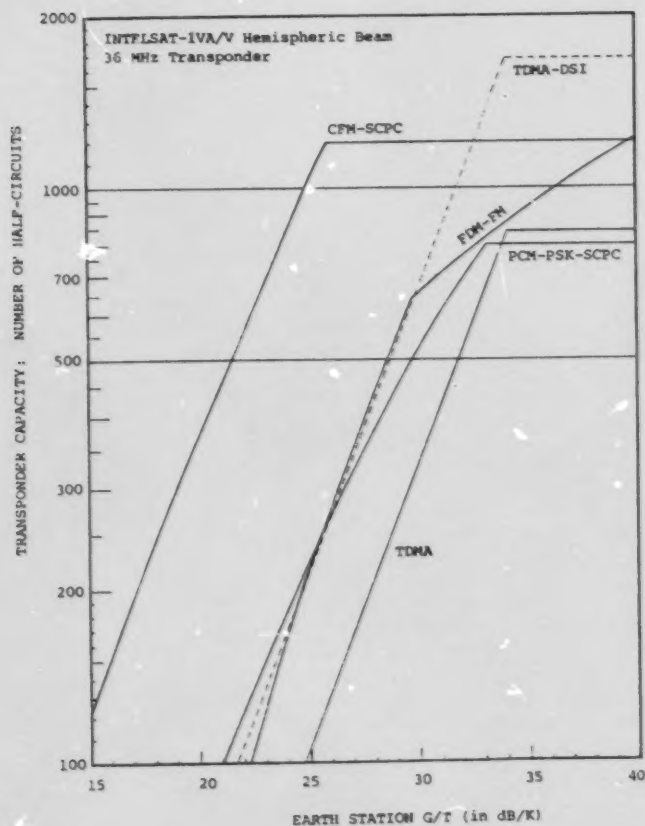
(1) FDM-FM-FDMA (Frequency Division Multiple Access):

This is suited for a heavy-traffic point-to-point system. By using a syllabic companding technique the transponder capacity can further be increased. When the number of stations accessing the transponder is increased, the capacity is rapidly reduced, due to third-order intermodulation distortion generated in the transponder.

(2) TDM-PSK-TDMA (Time Division Multiple Access):

This scheme is preferable for a heavy or medium traffic multi-point system, since the transponder capacity is not significantly reduced with an increase in the number of earth stations.

Fig. 2 TYPICAL TRANSPONDER CAPACITY



The capacity can be doubled simply by employing a digital speech interpolation (DSI) technique.

(3) SCPC (Single Channel per Carrier):

Application of this scheme in a light or medium traffic multi-point system is advantageous. The transponder capacity does not depend on the number of stations, and is maintained at an acceptable level by using a voice activation technique. When a demand assignment multiple access (DAMA) technique is applied, circuit utilization efficiency can be improved, depending upon the network configuration and the average traffic density of each circuit. Fig.3 shows the typical improvement which can be achieved by using a DAMA technique in a mesh-shaped network, for a different number of stations with different traffic densities per circuit.

In the design of a thin-route system, it should be noted that the transponder capacity cannot always be maximized due to an up-link power limitation. The use of a high power tube at remote stations can sometimes be prohibitive because of its primary power consumption and limited operational lifetime. The design should be a com-

promise between the use of a solid-state power amplifier and reduced satellite capacity by lowering the transponder operating point. In this case, the gain of the satellite transponder, for thin-route service, should be as high as practicable to the extent that interference from earth stations having access to adjacent satellites is maintained within a tolerable limit.

The multiple-access and carrier modulation schemes described above are limited to current conventional viable systems. With technology advancement in the near future, more advantageous schemes will probably be introduced and put into practical application. Hybrid modulation and ultimately SSB-AM for bandwidth-limited heavy traffic systems, and random access spectrum spreading and sophisticated encoding for power-limited thin-route systems are typical examples.

4.3 OTHER DESIGN CRITERIA

In addition to the capacity optimization, there are other various design criteria, each of which is related closely to one another. Such criteria will be briefly summarized and commented on.

(1) Network Configuration and Terrestrial Interface:

Any domestic/regional satellite system has to be integrated into or interfaced with the existing national network. In most cases, appropriate telephone signalling conversion is needed. The design consideration should recognize that a long post dial delay, due to satellite link propagation delay, must be avoided by eliminating the compelled sequence, and that a voice-activated carrier system is viable by converting a continuous signalling tone to a pulsed tone.

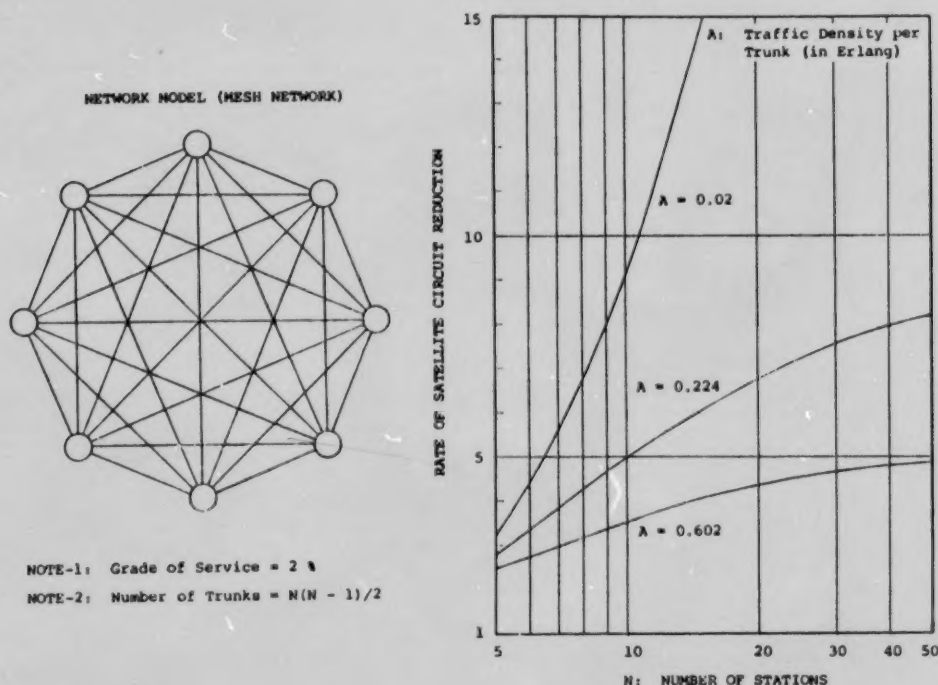
(2) Operational Versatility and Flexibility:

One of the significant features inherent in a satellite system is the versatility of being able to change the traffic pattern within the network. Use of DAMA will further enhance this flexibility. Carrier frequency agility and expandability, and linear polarization adjustability are other key points to operational versatility and flexibility.

(3) Construction and Implementation Simplicity:

In order to take advantage of a satellite system and minimize the construction period, the earth station design should be oriented to simplicity. Use of compact shelter(s) for equipment housing is one solution to shortening the construction period. For unforeseeable telecommunications demands, mobile or air-transportable entire station facilities are advisable.

Fig. 3 TYPICAL IMPROVEMENT OF CIRCUIT EFFICIENCY BY USING DAMA



(4) Operation and Maintenance Simplicity:

This criterion strictly applies to remotely located unmanned station. Use of highly reliable solid-state equipment throughout the station is of a prime importance. It is also possible to use a semi-permanent primary power system and low power consumption equipment to reduce the frequency of periodic preventive maintenance. A via-satellite supervisory system will facilitate fault finding, and equipment should be of a modular construction to allow simple replacement of a failed unit or module. The geographical location of maintenance/repair depots is also an important consideration.

5. EARTH STATION EQUIPMENT

The design of an earth station largely depends upon the choice of the earth station equipment. As a guide to earth station design, state-of-the-art equipment will be briefly reviewed for some important areas. In other areas, standard equipment will be readily available to meet any requirements from the system planners.

5.1 ANTENNA

From small size antennas for thin-route telephony and TVRO station to medium or large size antennas for heavy traffic stations, mechanical designs of adequate structural rigidity and electrical

designs to provide high aperture efficiency have been well established. Feed systems, with high polarization purity compatible with frequency reuse application, are no longer a critical design item. Taking into account the serious congestion on the geostationary orbit and the closer spacing of satellites, an improvement in radiation patterns without sacrificing aperture efficiency is now of great concern to antenna engineers.

5.2 LOW NOISE AMPLIFIER

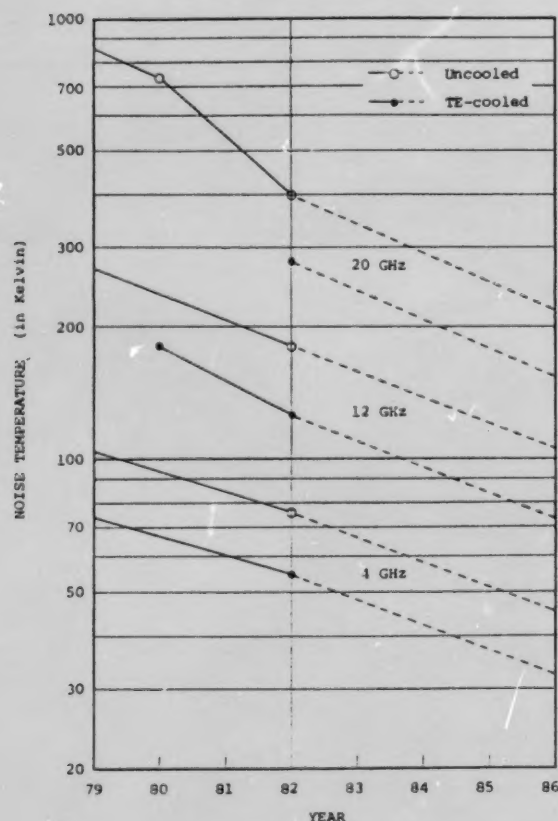
Cryogenically-cooled parametric amplifiers are a thing of the past and even parametric amplifiers are gradually being replaced in remote stations by GaAs FET amplifiers because of the latter's maintenance-free simple configuration and correspondingly high reliability and low cost. The improvement in noise temperatures of FET amplifier has been significant in recent years. Fig.4 shows the history and future prospects of reducing the noise temperature of production model amplifiers.

5.3 HIGH POWER AMPLIFIER

High power TWT's or Klystron's are still needed for a heavy traffic station and a TV up-link station.

In the international market, various types of HPA's are available with varying output power

Fig. 4 NOISE TEMPERATURE IMPROVEMENT
OF FET LOW NOISE AMPLIFIERS



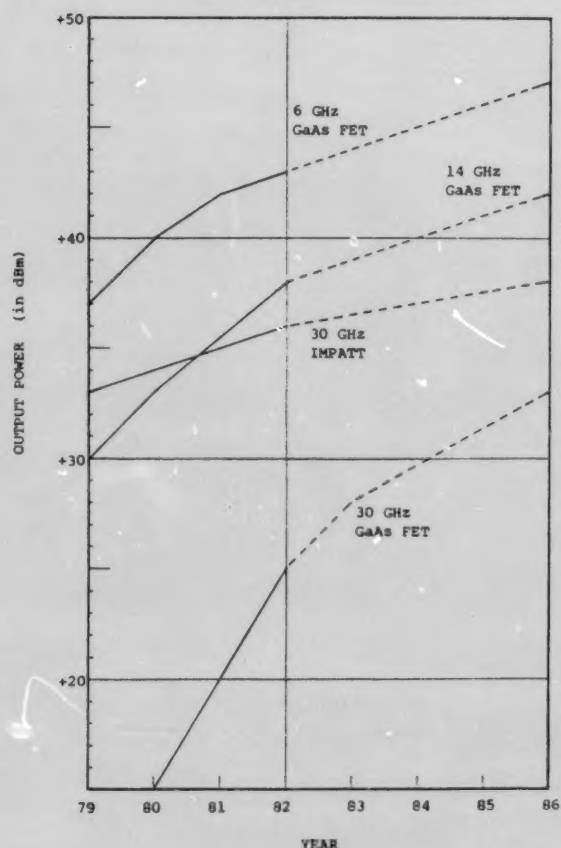
capability and radio frequency range. The choice of HPA should be made, taking into consideration:

a) that the total station cost, including cost of the primary power system in particular, should be minimized, and

b) that in view of maintenance simplicity, output power capability should be up to 3 to 4 kW with a forced-air cooling system.

For a thin-route remote station, a solid-state amplifier may be used. Depending upon the antenna size of the earth station and the up-link sensitivity of the satellite, a solid-state amplifier can handle several SCPC channels in a multi-carrier operation mode. In parallel with the reduction in noise temperature, there has also been a significant improvement in the output power capability of solid-state power amplifier. Fig.5 shows the history and future prospects of improving the output power of production model amplifiers.

Fig. 5 OUTPUT POWER IMPROVEMENT OF
SOLID-STATE POWER AMPLIFIERS



5.4 SCPC TERMINAL

Various types of SCPC terminals are available for voice and data transmission, e.g., PCM-PSK scheme for INTELSAT network, and CFM, ADM or ADPCM scheme for domestic and regional networks. In order to optimize satellite capacity, the choice of the modulation scheme should be made in accordance with the signals or information to be transmitted.

5.5 TDMA TERMINAL

The design of TDMA terminals with associated signal processing equipment has been well established for various transmission speeds, from 128 kbps, used for the SPADE common signalling channel, to 120 Mbps used for the INTELSAT system. Various terrestrial interfaces for operational flexibility are also available, e.g., single- or multi-destination DSI, PCM plesiochronous and doppler buffer, digital transmultiplexer, etc.

5.6 VIDEO SIGNAL PROCESSING EQUIPMENT

In order to improve the transmission efficiency of a video signal for high-quality TV program distribution and teleconferencing, various video signal processing schemes have been developed. These schemes are based mainly on digital encoding and band-compression techniques using frame or line correlation of the video signal.

With horizontal or vertical compression, or field interlace, two broadcasting quality video programs can be simultaneously transmitted through a transmission channel which is normally used for one video signal.

Digital encoding using a band-compression technique can be used for various transmission speeds with corresponding signal qualities, e.g., 1.544 Mbps for teleconferencing quality, and 20 Mbps or higher speeds for broadcasting quality. With the use of digital processing and solid-state memory, a 3.4 kHz voice channel or channels can carry frozen pictures with a transmission speed per picture corresponding to channel bandwidth and picture elements.

6. SUMMARY AND CONCLUSION

In order to cover isolated areas over a wide region where the use of conventional terrestrial interconnection is prohibitive, the introduction of satellite communications is an attractive and viable solution. The possible configurations and applications of domestic/regional satellite system have been reviewed, and the essential criteria for system planning/design have been examined. The authors sincerely hope that this paper will be of some help or assistance to management executives and/or engineering staff who are or will be responsible for domestic/regional satellite system planning/design, and thank all the persons concerned for providing an opportunity to present this paper.

World Communications Year (WCY), 1983:
Development of Communications Infrastructures

R. E. Butler
Secretary-General
International Telecommunication Union

Chairman,
Your Excellencies,
Ladies and Gentlemen,

I am extremely grateful to my friends of the Pacific Telecommunications Council for inviting me to this excellent luncheon and thereby offering me the occasion of welcoming together with you "World Communications Year (WCY), 1983: Development of Communications Infrastructures."

Since my recent election to the office of Secretary-General of the International Telecommunication Union, this is my first opportunity to address such a distinguished group of communications leaders, scientists, educationalists, engineers, economists, technicians, lawyers, financiers, politicians, researchers, social scientists, users and others who share a mutual interest in creating not only an awareness of the telecommunications needs of the Pacific Area but also, and more important, to assuring contributions to their rapid development, as well as for the improvement of the world's telecommunications infrastructures.

I appreciate the great effort which the authorities and the entire communications community of Hawaii have made in this respect in the past--and no doubt will continue to make in the future. One example worth mentioning has been the pioneering efforts in the application of satellite communication technology by the University of Hawaii. In cooperation with educational and health institutions of the Pacific Area, it has been one of the pioneers in the development of thin-route and multi-destination (teleconferencing) satellite and land-based rural communications infrastructures. These efforts have been built upon by individual inputs throughout the region--private citizens, public service interested officials and for some time the University of the South Pacific and its community of users and cooperators, as well as Government Leaders in their search for the means to increase the pace of Development.

I would like to pay tribute to the value of those experiences and to the leaders of the South Pacific Forum who have reached an understanding on the importance of continued concerted action in the domaine of new telecommunication means. We, in the ITU Secretariat, are pleased to work with the South Pacific Bureau for Economic Cooperation (SPEC) in the drive for practical low-cost telecommunication service results. We are dealing with the necessity to recognize the special multi-purpose communication needs of the area.

The South Pacific has provided us all with a very useful experience. Indeed, it has been reflected in the stimulus given by the ITU Secretariat's

fostering of satellite and low-cost/capacity telecommunication systems to service communications needs--initially in times of natural disasters and, subsequently, with enlarged cooperation progress towards the realization of rural and inter-island national telecommunication development, especially to the unelectrified areas.

Many of you know of the ITU Secretariat's GLODOM concept which is intended to accelerate rural development by appropriate sharing of resources, including the proposed use of low cost satellite capacity and modern telecommunication technology. It is a global issue. It necessitates global attention.

ANOMALIES IN WORLD TELECOMMUNICATIONS DEVELOPMENT

Before I report on progress in the preparation and celebration of the WCY, I wish to stress that there are many anomalies in world telecommunication development and explain some of the actions taken by the recent ITU Plenipotentiary Conference, Nairobi, 1982. You may wish to analyse the psychological, political, and social effects which we can expect "total communications infrastructure development" to have on the inhabitants of our paradoxical planet earth, where hunger and abundance, Stone and Information Age conditions, population explosion and underpopulation exist virtually side by side.

In recent decades, the tempo of technological development has accelerated very considerably and continues to gain momentum. Today's college graduates and modern telecommunications are almost the same age. Only about 20 years have passed since the marriage of communications and computer technologies began. Each using the other's philosophies more and more. Modern telecommunication is their offspring. As the scientific base expands, the telecommunications scene is growing and changing. Now, with microchips making computer systems more like telecommunication networks and vice versa, the regulators are giving up attempting to draw a line between computers and telecommunications.

Yet, this revolution is taking place when the vast majority of mankind does not have an ordinary telephone or even access to one. This gap--the telecommunications gap--is daunting. We are dealing, of course, with the ability or lack of it to transfer information, by voice or recorded means, over a telephone circuit which, with today's technology, can be reproduced without complexity in recorded, written text or visual form anywhere within our planet--and at very low cost.

We must view with concern the plight of the developing countries where a high percentage of the population, some 600 million people--including virtually all those with an annual income of less than 50 dollars--live in rural, isolated and underprivileged areas and where the infrastructure such as roads, water services and electricity is very poor or non-existent.

A survey of the telecommunication scene today reveals the unbalanced distribution of communication services throughout the world. To mention only two of the most representative telecommunications indicators, the world's telephones and television sets--there were in 1982, about 550 million telephones and 600 million television receivers. Some 15% of nations make use of 90% of those telephones and TV receivers, 85% of nations use the remaining 10%.

No one doubts any more the importance of communication and information transfer for Development.

The problem is how to translate those concepts into action, with the appropriate priority of investment and technology application, consistent with national and regional aspirations. Action necessitates decisions by Governments--Developed and Developing--as to how best they can, or will, marshal resources for such developmental considerations and the achievement of practical results.

CASE STUDIES ON DIRECT AND INDIRECT BENEFITS FROM TELECOMMUNICATION SERVICES

The ITU has commissioned or carried out much work to demonstrate the link between telecommunications and economic and social progress, i.e. consideration of the "public good" and not only the narrower financial rate of return. The objective of several studies was to identify and, to some degree, quantify the direct and indirect benefits of telecommunications for development with emphasis on rural areas.

The preliminary results of some case studies which have been completed show that the direct benefits from telecommunication services are only a fraction of the indirect benefits. For example, in an overview report for the ITU by the Massachusetts Institute of Technology and Cairo University, studies of telecommunication service impact on 146 out of a total of 4,200 villages in Egypt show that the ratio of indirect to direct benefits in different sectors were assessed as follows:

- service organization sector 85:1
- trade sector 69:1
- capital equipment sector 126:1
- artisans sector 78:1

The study took account of the following hypotheses:

- assessment of the monetary benefits measured by the difference between the cost of a telephone call and that of alternative means of communication,

- time savings as a result of the use of telephone measured by the number of working hours saved,
- indirect monetary benefits measured by the value of the losses avoided due to the use of the telephone in emergency situations, and
- indirect monetary benefits measured by the efficient use of capital and capital equipment.

Interesting indications have been assessed elsewhere. For example, improved communication, as a recent study of the Kenyan economy has shown, can enhance the economic performance of sectors in developing countries.

Such case studies on the importance of telecommunication to particular sectors in the development process provide valuable information in the context of national planning and assignment of investment priority. In short, and looking specifically at the developing countries, case studies help to answer the question "What do they lose if they don't have it?"

I wish to add a few words on the problems of exodus from the remote areas.

For many developing countries, a major, and growing, social and economic problem is a rate of rural/urban migration in excess of the urban centres' capacity to absorb additional population. The problem is a complex one since, on the one hand, a certain amount of internal migration may be desirable from area to area in order to ensure an adequate supply of labour for newly emerging industrial activities and tertiary, or service, sector growth. On the other hand, when the number of persons migrating to urban areas is too great or when there is an imbalance in the skill levels and aptitudes of the migrants relative to the needs of the urban sector, the results may be urban congestion, over-crowding, strains on the supply of food, housing and government services and overall strain on the social and economic fabric of the country.

Telecommunications can potentially ameliorate at least part of this strain through their impact on the economic and social development of rural areas. To the extent that telecommunications can contribute to an improved social environment in non-urban areas, they can reduce the desire of many persons to migrate to urban areas. The possible impact in this regard can come not only from enhancing living conditions in the rural area itself but also from reducing the feeling of isolation felt by many rural inhabitants.

These are only a few explanations of the indirect benefits of telecommunications. I could have mentioned others, like spin-off economies in both conservation and better use of energy, in reduced transportation through the provision of telecom-

munications, etc. These case studies underlie the necessity for governments, international investing and aid authorities and policy makers to take a new look at the investment priorities and also the financing arrangements for telecommunications in the wider perspectives of contributions to economic and social development.

ITU PLENIPOTENTIARIES TAKE ACTION

In recent years, governments of Member States of the ITU have shown their concern for the uneven telecommunications penetration throughout the world.

When the Plenipotentiary Conference opened on 28 September 1982, it was obvious that Member States wished to reinforce the important and traditional international regulatory/standard setting, coordination and planning functions of the ITU. On the other hand, there were many proposals concerning an increase in the direct and specific contributions that the Union should make to the development process--in reality towards the stimulation and the realization of support to social and economic progress through telecommunication development as an essential part of the role of the Union as a Specialized Agency of the United States System.

The Plenipotentiary Conference adopted *inter alia*, a number of impressive resolutions related to these elements of cooperation.

The question of the funding of contributions to development was considered. Being realistic, no one doubted that the problem was much larger than the ITU. Some call it technical cooperation, some say technical assistance "in the field." Others use both terms. We could think of other means of identification.

The issue was, I believe, one that called for comprehensive understanding of the different perceptions of cooperation and of priorities of what Members (Developed and Developing) pay for in contributing to the Union, and what they expect to gain from their membership.

There was a general consensus that the United Nations Development Programme funds for development of telecommunications are insufficient to cover all the needs of assistance and that efforts should be made to obtain a greater share of UNDP and other programmes resources for this sector. It was also agreed that the ITU itself should provide some direct support to the application of appropriate technological innovation in communications. The delegations representing ITU's 157 Member States came up with a series of plans designed to achieve these objectives and devoted considerable attention to increasing the scope and effectiveness of the ITU's technical cooperation and assistance activities. In particular, they:

- revised the International Telecommunication Convention to provide an intergov-

ernmental treaty (Nairobi, 1982) which binds Member States to provide more specific assistance to development and to contribute in various ways inside and outside the Union to these fundamental objectives,

- instructed the Administrative Council and the Secretary-General to carry out the necessary studies with a view to strengthening the ITU's regional presence, to foster closer cooperation within the regions,
- decided to set up a special voluntary programme for technical cooperation based on financial contribution, training services or any other form of assistance designed to meet the telecommunication needs of developing countries.
- recognized the need for special action to be taken to give higher priority in investment and aid programmes for telecommunications because of the enlarged importance of telecommunications to socio-economic development,
- issued guidelines concerning: training fellowship programmes; the recruitment of experts for technical cooperation projects; special facilities for the least developed countries; the ITU's participation in the United Nations Development Programme (UNDP), the application of science and telecommunication technology in the interest of developing countries; training standards for telecommunication staff; the organization of seminars; research on the interrelation between telecommunication infrastructure and development, as well as studies to assure more effective results.

Very significantly, the Conference decided also to set up during World Communications Year (WCY), 1983: Development of Communications Infrastructures, an "Independent International Commission for World-Wide Telecommunications Development." This Commission, to be composed of representatives of the highest decision-making authorities of administrations, operating agencies and industry in developing and developed countries as well as major financial institutions and other bodies, will have the following terms of reference:

1. to examine all existing and possible future relationships between countries in the field of telecommunications involving technical cooperation and a transfer of resources in order to identify the most successful methods of such transfer;
2. to recommend a range of methods, both tried and untried, for stimulating telecommunication development in the developing world using appropriate and proven technologies in ways which:

- (a) serve the mutual interest of governments, operating companies, the public and specialized user groups in the developing world and of the public and private sector in the developed countries; and
- (b) lead to the progressive achievement of self-reliance in the developing world and the narrowing of the gap between the developing and developed countries;

3. to consider the most cost-effective way in which the Union could stimulate and support the range of activities that might be necessary to achieve a more balanced expansion of telecommunication networks.

The Plenipotentiary Conference also adopted an extensive timetable for not less than 13 ITU world and regional administrative radio and broadcasting conferences between 1983 and 1989 (including for a World Administrative Telegraph and Telephone Conference to treat the regulatory needs for new information and data exchange requirements) to enable the development and review of basic agreements and procedures for the planning and operation of telecommunication systems and to ensure the co-existence and interconnection of systems and networks of individual countries.

Furthermore, the Conference made provisions for the continuing studies, standardization and technical advice through the Consultative Committees (CCIR and CCITT) including the preparation of appropriate technical data to assist preparations and decisions in the various conferences.

Thus all States of the world have also reinforced through the supreme Organ of the Union the necessity for the creation of adequate communications infrastructures, which I believe is the sine qua non for the establishment of the New International Economic Order and of the New World Information and Communication Order.

How do national and international institutions seek to foster, to promote and, importantly, to remedy the shortcomings upon which I have touched? What are the responsibilities of the ITU?

WORLD COMMUNICATIONS YEAR (WCY), 1983: DEVELOPMENT OF COMMUNICATIONS INFRASTRUCTURES

Many Governments, Ministers and Heads of delegations had already hailed the proclamation of World Communications Year (WCY), 1983: Development of Communications Infrastructures, by the United Nations General Assembly, with the International Telecommunication Union serving as the lead Agency for the Year. The Plenipotentiary Conference adopted a resolution on the Year.

The Conference recognized fully that the basic objectives laid down by the General Assembly were:

"to provide the opportunity for all countries to undertake an in-depth review and analysis of their policies on communi-

cations development" and "to facilitate the accelerated development of communications infrastructures".

I see the Year as an action-oriented programme of activity for those basic objectives. More than ever before, every facet of human endeavor depends on the availability and interference-free working of communications facilities, whether we are talking about maritime, aeronautical, space postal services, sound and television broadcasting. An ever-increasing dependence on telecommunications is perceptible in health, agriculture, mining industry, science, transportation, environment and education. Accordingly, the United Nations and 16 of its Specialized Agencies, from UNESCO, UPU, ICAO, IMO, WMO to FAO, are working closely together with the ITU to implement their programmes, projects and activities of the Year.

This is, of course, a formidable undertaking. It meets an urgent need felt today in all countries, whatever their degree of development. Indeed, the basic choices to be made, given the enormous technical panoply available, are extremely difficult, if only because of their financial implications. On the other hand, with appropriate international cooperation and use of resources, the financial sharing implications can be minimized considerably.

Although World Communications Year will undoubtedly foster the coordination of infrastructural development at the international level, its real impact must be at the national level. National infrastructures must be the first to benefit. After all, the world communications network is made up of interconnecting national infrastructures.

The World Communications Year programme therefore gives priority to the importance of actions at the national level. It aims at the mobilization of national action. Such action includes the establishment of national committees responsible for coordinating the preparation and implementation of each Member State's programme. These committees, which should cover all sectors of activity involved in the development and use of communications infrastructures, might serve, where they do not already exist, as forerunners to national coordination committees essential to guide communications infrastructure development policies.

With suitable representation on the committees of economic planners, policy makers, investors, providers and users of communications services and facilities, all the elements will be available to permit an in-depth review and analysis of national and international policies on communications development.

In addition to the national programmes, it is planned, with international aid, to implement specific projects known as "pilot projects" which should give some valuable and instructive models for all countries. This is an area in which administrations and operating agencies and manu-

facturers of industrialized countries have an extremely important role to play.

THE CHALLENGES

As I have alluded, at the outset, an obstacle--perhaps one of the major obstacles now--between promise and practical application is the lack of common understanding at various levels, policy makers, economic planners, specialist users or potential specialists on what, specifically, telecommunication can accomplish for them.

A major objective of WCY is to increase the awareness and understanding of national policy makers, economics planners, investors, and all providers and users of communications services and facilities of the importance of communications in the development process. A better understanding of the benefits to be derived from a well conceived and implemented communications infrastructure will lead to a better balance in development and more effective utilization of the limited resources available for this purpose.

It must be the objective of decision-makers in all fields of telecommunications to translate our fascinating developments so that all may grasp the value and meaning of the new tools at the disposal of their Authorities and Communities.

International cooperation is an absolutely indispensable agent of transition to a new global economic framework, to the building of national and financial capacities and the upgrading of human resources in developing countries, and to providing the catalytic force essential to sustain progress in development at a time of near-revolutionary economic change and of severe constraint on development resources.

The provision of adequate resources to maintain the development process is of increasing concern to both the industrialized and the developing countries. They have mutual interests. However, it is my experience that well thought-out and carefully planned projects in the field of communications, with clearly defined direct and indirect benefits, will generally be well-placed to attract investment funding. The challenge is to be found in preparing the plans and project proposals and in bringing the development requirements and the necessary funding together.

The World Communications Year provides us all with a vehicle to make an effective contribution. The extent of our contribution depends upon cooperation--cooperation of and between all governments, authorities, specialists in the private sector, educationalists, etc.

International technical cooperation does not consummate development; it facilitates tangible steps towards progress.

A great number of Heads of States, among them the President of the United States, have already announced their participation in the Committee of

Honour for World Communications Year, 1983. The patronage of Heads of States, complemented by the support of the administrations of ITU Member Countries and of the "Independent International Commission for World-Wide Telecommunication Development," as well as the cooperation of the organizations of the UN system, should assure significant support for a successful Year. Results depend upon resources and action at all levels.

Today, I invite all participants at the PTC'83, their authorities, entities, and institutions, and members of all communications organizations and societies, to support the action and special endeavors undertaken in the framework of WCY to accelerate the development of communication infrastructures at the national and international levels. The Year Secretariat at ITU Headquarters would greatly appreciate receiving your voluntary contributions in cash, kind and services.

Given the tasks that ITU has officially been assigned as the Lead Agency for WCY 83 ... given what the ITU is demonstrably capable of doing ... given what clearly has to be done in the interests of the developing and industrialized countries alike, ITU must receive backing to get on with all its many jobs. Your support is vital for the success of ITU's mandate in leading the World Communications Year, 1983, as a potential for a significant contribution towards cooperation in the realization of the harmonious development of a tightly-knit world telecommunication network.

Panel Discussion

"Business Requirements/User Needs in the Pacific"

Notes

Economics of Spectrum Allocation

William H. Melody
Simon Fraser University

1. Abstract

The economic, political, and social structure of all societies is becoming increasingly dependent on telecommunications systems. These are dependent, in turn, upon the radio spectrum which is now recognized as a major and potentially scarce resource. In this paper a range of alternative methods of spectrum allocation, the role of the International Telecommunications Union, and the need for spectrum planning and rules for sharing the radio spectrum are discussed.

2. INTRODUCTION

As a natural resource, the radio spectrum is enormously valuable. High technological societies are entirely dependent upon information transmitted over telecommunication systems -- telephone, television, newswire, data and information services, etc. The very functioning of most industrial, political and military institutions requires effective and efficient networks for information generation, classification, transfer, storage and retrieval. In virtually all cases, these information networks are provided over telecommunication facility systems -- such as microwave, satellite, mobile, etc. -- that are dependent upon the radio spectrum. Indeed, if any high technology society were forced to adjust to the loss of access to the spectrum, the impact would be overwhelming. Not only would the costs be astronomical in economic terms, but that society would have to fundamentally restructure its economic, political and social relations.

With the many advances in electronics, communications, computer, and related technologies over the past 30 years, and many more on the horizon, high technology societies are becoming ever more dependent upon information networks provided over telecommunication systems that require the use of the spectrum. The "information society" that is the subject of so much recent discussion and research is a society structured around the spectrum. The spectrum is the cornerstone, and the achilles heel, of today's technologically dependent societies.

If this is so, why has the spectrum, until recently, received so little attention in national and international affairs? Primarily because of the unique properties of the spectrum resource, the general lack of knowledge and understanding of the significance of the spectrum outside the small technical community directly involved, and systems of national and international spectrum allocation that have been able to resolve major problems among the limited number of users on the basis of administered technical trade-offs. Now the spectrum has become a major issue of international policy because the problem of spectrum scarcity has reached a much higher plateau.

The new demands of developing nations, together with an enormous expansion of spectrum demand in high technology nations for both domestic and

international communications has required a reconsideration of the traditional standards for spectrum allocation. For perhaps the first time, there is a real possibility of absolute denial of important segments of spectrum for some future claimants. And even where accommodations for new spectrum claims can be made, the opportunity cost of receiving a second, or third choice spectrum assignment are substantial and increasing rapidly. The second choices increase the costs of telecommunication equipment and services not only in absolute terms, but also in comparison to the competitive equipment and services supplied by those who have the first choices in spectrum assignment. As a result, the traditional criteria for spectrum allocation and assignment are now being reconsidered, both for international, and for many countries, national allocations.

3. ALLOCATION OF THE SPECTRUM BY ADMINISTRATIVE SYSTEMS

When valuable economic resources are allocated to users at a nominal cost, this system will remain viable only as long as awareness of this very favourable state of affairs is limited to a relatively few beneficiaries. Once a significant number of potential beneficiaries begins to make claims, it will become necessary to establish a formal system of rationing or allocation of the resource among the claimants. Systems of allocating resources can be classified generally into market systems or administered systems. Most economic resources and products are allocated through market systems, with prices reflecting current exchange values.

Administered systems employ non-market criteria for allocating the resource. A set of decision criteria is established reflecting technical, economic, social, political or other standards. An administrative authority is established to judge the compliance of applicants with the standards and to select among competing applicants.

Of course, market systems and administered systems are not entirely independent. All markets require a set of administrative rules, e.g., laws of property and contract, for their functioning. In addition, they require a common understanding of acceptable and unacceptable market behaviour. On the other hand, all administered systems are

influenced by market forces acting on the administrative process, and many employ selected market criteria as one factor in the set of factors upon which administrative judgements are made.

The radio spectrum traditionally has been allocated by administrative authorities at both the national and international levels. When the spectrum is allocated and assigned, no "price level" is charged to users for the spectrum resource obtained, although the various spectrum claimants do incur the costs of necessary participation in the administrative process. The market price for the spectrum itself is zero. But, the economic opportunity costs of the spectrum are very high. Spectrum allocations for one use deny its allocation to valuable alternative uses. And recipients of spectrum assignments are able to realize substantial savings because of the spectrum assignment.

All administrative processes are political in character. The necessary judgements require a balancing of different, competing interests. The criteria specifically identified as factors to be considered in administrative decisions may be technical, economic, social and/or narrowly political. If the major political and economic interests affected by an administrative process remain stable in their relative power and influence over time, and the basic character of the administrative problems does not change significantly, the process will soon evolve into an apparently technical one. The evaluation of technical trade-offs and the selection of technical standards will reflect the political and economic influence of the established interests. But to an outside observer, the invisibility of the political and economic influences may make them appear absent from the process.

There are significant advantages in this state of affairs to the established interests. By resolving their political and economic differences in the labyrinthian trenches of technical issues, an enormous barrier to entry is created for outsiders desiring to break into the process. Outsiders must somehow reflect their broad political and economic interests in terms of complex technical issues, where they are at an overwhelming disadvantage. If outsiders pursue their broad political and economic interests directly, without regard to the technical complexities, they will be accused of "politicizing" a technical process, ignoring the technical realities and demanding the technically impossible. Indeed, this has occurred.

4. SPECTRUM ALLOCATION THROUGH THE ITU

Until recent times, spectrum allocation has been characterized by relatively stable political and economic influences from dominant governmental and industrial interests from the developed nations. The essential problem for the International Telecommunications Union (ITU) has been to accommodate, by means of technical standards and adjustments, the new demands for spectrum and new telecommuni-

cation technologies. Spectrum allocations have been made on a first come, first served basis. Second and third waves of demand have been technically fitted into a system where the early bird got the best spectrum. Indeed, soon after its establishment, the ITU took on the character of an "old boy's club" of engineers, as the relatively stable political and economic influences became invisible even to many of the participants.

WARC-79 marks a watershed for change in the underlying structure of political and economic influence, upon which the technical spectrum allocation decisions are made. The possibility of total exclusion from important portions of the spectrum, and the disadvantages of low priority allocations have been recognized as major policy issues, not simply extremely complex technical ones. The fundamental issue of priorities among spectrum uses and users is now front and centre, and the political and economic criteria for priority selection will no longer be submerged entirely in technical considerations.

The spectrum is much more than a natural resource. If that were all it were, nations could decide whether to use it, save it, lease it, or sell it. The spectrum is a social resource in the broadest sense. It is not subject to private or even national ownership. Interdependence among users is extremely high. Use by one party may restrict or prevent use by others. Co-operation among users is essential if the spectrum is to be used effectively by anyone.

National, regional and world-wide co-operation in spectrum allocation and use exists now (although many nations have been excluded from the process), and has been maintained by opposing sides even during war time. Although interference and congestion can reduce effectiveness and efficiency, spectrum capacity cannot be exhausted, as can the stocks of other natural resources. In fact, with technological advance, spectrum capacity has been enhanced continuously.

Measurement of the actual use of the spectrum or even of rights to use it, cannot be objectively specified. Rather, spectrum rights are probabilistic in nature depending upon environmental conditions at the time and use of the spectrum by others. Rights to use the spectrum are not susceptible to legal enforcement as are private property rights.

The spectrum has been recognized as a social resource by both international law and national law in many countries. As a unique form of social property, the spectrum is a "commons" of the world. Its effective and efficient allocation and use can only be determined by a set of sharing rules that will reflect the interests, values and power of all affected parties. What is happening now is that the new interests and different values of the developing countries are pressing to change the international sharing rules established by a small group of high technology nations. The

latter have established a massive telecommunications infrastructure on the basis of inherited sharing rules that reflect only their interests and a much simplified scarcity problem.

5. INCENTIVES TO EFFICIENT SPECTRUM UTILIZATION

One major difficulty with administrative allocation of the valuable spectrum resource is that there is little, if any, economic incentive to conserve. If the cost of using spectrum is essentially free to the user, there is an incentive to waste and even to stockpile and hoard spectrum. Thus, as congestion and scarcity become more serious, it is important to seek methods of creating much stronger incentives to conserve. In addressing this issue, nations often tend to respond differently depending whether the problem is at the national or international level, and whether or not the nation is now using spectrum inefficiently. As a result of WARC-79, and related events, the high technology nations have agreed to return to ITU for reallocation, significant quantities of spectrum that had been obtained in prior allocations, but which is not being used, nor expected to be used, in the foreseeable future. This is an important first step toward the elimination of stockpiling and improving efficiency.

In the United States, and to a lesser degree in Canada, there are proposals to impose licence fees on spectrum users at sufficiently high levels to make waste and inefficiency more costly to the user. Also under discussion is the principle that spectrum licence fees should be set at levels that would capture for the public, the economic rent from using the valuable spectrum.

Although WARC-79 resolved some of the most pressing current technical issues, and debated fundamental underlying policy issues that had not been questioned within the ITU since its creation, no long-term policy goals or directions were clearly specified. This has set the stage for continuing WARC negotiations of the underlying principles for sharing the spectrum.

The WARC negotiations brought to the forefront the apparent conflict between equity and short-run economic efficiency. The developing nations can claim a greatly expanded share of the spectrum on grounds of basic equity. But, for the immediate future, the high technology countries -- with certain exceptions -- have the greatest and fastest growing demands, and can make more efficient use of the spectrum. Although this issue has not been confronted directly as yet, the direction for its resolution is in the form of compensation payments, i.e., fixed term leases. Spectrum benefits that the developing countries cannot achieve by their own use in the short-run, can be realized through rental payments based upon the value of the spectrum. Such a compensation scheme would permit expanded use by the high technology countries during a transition period and stimulate research and development and the expansion of

spectrum capacity to ease the necessary longer-term adjustments.

The apparent conflict between spectrum planning, or no planning, is mislabelled and often misinterpreted. In any administrative system, there must be planning. There always has been system planning at both international and national levels. The first come, first served principle is a plan. Its successful implementation requires acceptance, or at least acquiescence by all parties.

The only sensible interpretation of this debate is that it is between different kinds of planning, with different policies and different assessments as to whether the proposed policies are good or bad. The real issue is straightforward. An immediate adoption of massive changes in spectrum rights favouring developing nations at the expense of high technology nations could result in the allocation of spectrum to the developing nations that they are not ready to use, therefore keeping it idle, denying real demands from high technology countries and even possibly making obsolete some existing equipment.

But these are short-term problems to be handled through a phased adjustment process, employing transition rules such as compensation payments suggested above. The important policy issue is that the adjustment process must be pointed toward a long-term goal that reflects revised, equitable sharing arrangements. Unfortunately, WARC-79 provided very little guidance as to what those long-term goals should be. Without specification of the long-term goals and the underlying principles of spectrum allocation, spectrum use will continue to be directed by the existing unbalanced world economic order. With long-term goals and underlying principles established, communication technologies and markets can be directed, through a series of adjustment policies, to achieve them. What is surprising is that the United States, in particular, and the high technology nations in general, refuse to recognize in the international spectrum policy debates, the very principles of spectrum sharing that they employ in making their domestic spectrum allocations and assignments.

6. CONCLUSION

The gradual working out of revised spectrum sharing rules, and the adoption of adjustment policies are not going to solve all the major issues surrounding the desire of many nations to protect and control their information environment. International spectrum allocation policies that reflect satisfactory principles of sharing are, of course, a necessary condition. But they are by no means a sufficient condition.

Free information flows, like free trade, are justified only if the flows are balanced, and no nation or interest group exercises monopoly power over the terms and conditions of information

exchange. For a developing country, the outward flow of specialized data about its domestic resources, its markets, its economy, its political and social structure and the private lives of its leading citizens, in return for an endless supply of U.S. television reruns is hardly a balanced flow. A crucial first step toward the creation of an international information environment in which "free" flows will be balanced flows is the establishment of a balanced and equitable set of sharing rules for the radio spectrum.

If this is to be achieved in any realistic way, international spectrum negotiations will have to proceed at two levels: the formulation of specific long-term policy objectives; and the development of transition policies and rules that provide the necessary adjustments to reach the long-term objectives, but which encompass necessary accommodations over the transition period. For effective participation at both levels, detailed knowledge of the technology and its technical parameters will be necessary. To a major degree, spectrum policy still will be negotiated in the trenches of technical trade-offs and standards.

**INTELSAT: THE GEOSYNCHRONOUS ORBITAL
ARC AND THE THIRD WORLD**

Dr. Joseph N. Pelton
Executive Assistant to the
Director General
INTELSAT
Washington, D.C.

1. Abstract

This paper reviews the historical growth and development of the INTELSAT global satellite system. In particular, it emphasizes the growth of INTELSAT services, from the initial overseas fixed satellite services into new areas, such as domestic satellite services and thin-route communications. It explores the potential of INTELSAT providing regional satellite services and a wide range of new types of services through a multipurpose space platform in future decades. The special relevance of INTELSAT's services to third world countries is explained in terms of providing cost-effective and reliable services on a financially equitable basis that allows these countries to invest in the INTELSAT space segment. The efficiency with which INTELSAT utilizes the geosynchronous orbital arc is demonstrated in a number of different comparative statistics. The fact that INTELSAT VI (to be launched in 1986) will provide more than 150 times the communications capacity of INTELSAT I is particularly highlighted as an example of the gains that have been achieved. General principles whereby all countries of the world — developed and developing — can cooperate in the effective utilization of geosynchronous orbital arc, are also outlined. In conclusion, the paper notes that INTELSAT is an excellent mechanism for ensuring not only equitable access to the geosynchronous orbital arc for all countries, but also a potentially revolutionary tool whereby dramatic strides could be made in telecommunications development by third world countries, in order to achieve such 21st century goals as universal education and literacy, worldwide industrialization, and a high standard of living for all humanity.

2. **INTRODUCTORY REMARKS: THE VIEW
FROM THE MIDDLE OF A 150-YEAR EPOCH
OF CHANGE**

In December 1900, Mr. John E. Watkins, Jr., published an article on what he thought may happen during the next 100 years. Mr. Watkins' predictions, which were based on an early version of a Delphi Survey, came up with a number of predictions which have not exactly been borne out. Namely, that "mosquitos, the housefly, and roaches will have been practically exterminated;" "there will be airships but they will not successfully compete with surface cars and water vessels for passenger or freight traffic;" "few drugs will be swallowed or taken into the stomach;" and that "there will be no c, x, or q in our everyday alphabet." These predictions may seem somewhat quixotic (note quixotic still contains q, x, and c), but then no Futurist has a perfect record.

Mr. Watkins, however, also predicted that automobiles would be substituted for horses, that there would be aerial warships, and that wild animals would become an increasingly endangered species. In the field of telecommunications, Mr. Watkins predicted that wireless telephone and telegraph circuits would span the world and that a "husband in the middle of the Atlantic will be able to converse with his wife sitting in her boudoir in

Chicago." Of course this last prediction might, in today's society, have had the wife calling home. Nevertheless, the introduction of satellite maritime services in the late 1970's and the likelihood that aeronautical communications will soon follow, seems to ensure that this prediction will certainly come true before the 21st century.

Mr. Watkins foretold other telecommunications inventions as well. He noted that one would be able to telephone to China as easily as one would from New York to Brooklyn. An automatic signal would connect with any circuit in the locality without the intervention of a "hello girl." Mr. Watkins also told of how we "will see around the world, that persons and things of all kind will be brought closer with cameras connected electrically, at opposite ends of the circuit, thousands of miles at a span." He predicted "that American audiences will be able to view the coronations of Kings in Europe and the progress of battles in the Orient." This prediction seems incredibly prescient in terms of recent coronation ceremonies and Vietnam war footage that were actually carried on the INTELSAT System in recent years.

Poetically, Mr. Watkins expressed the possibility of live television coverage of world events in these terms: "thus

the guns of a distant battle will be heard to boom when seen to blaze." These remarkable views of the future of Mr. Watkins cannot help but make one look back over the incredible changes that have occurred over the last 80 years and speculate on the prospects for even more incredible changes that may well occur by the middle of the 21st century. It is interesting to note that whether the forecaster is Mr. Watkins in 1900 or a contemporary futurist, it is the technological issues and developments that are most easily foreseen, while the economic, social, and cultural impacts (such as the women's rights revolution) are much more difficult to project.

It is likewise true that technological innovations themselves, such as the invention of airplanes, or cars or space vehicles, are usually foreseen as positive developments and the disadvantages or problems they might engender are hard to anticipate. Indeed, there is considerable irony in the fact that the London city council at the turn of the 20th century felt threatened by the enormous cost of removing hundreds of thousands of tons of horse manure from their fair city's streets; and thus the horseless carriage was heralded as a cure to an "atrocious pollution" problem. Things do not always turn out as expected.

In the areas of telecommunications, many innovations can be foreseen by 2050. In the Delphi Survey that I conducted about a year ago, a sizable majority of respondents foresaw these changes in developed countries (i.e., the O.E.C.D.) by the year 2000:

- (a) a 5% to 10% market penetration of videotext;
- (b) growth of videoconferencing service to 10 to 25% of business communications volume;
- (c) implementation of home telecommunications and computer centers in 25% of the homes;
- (d) direct broadcast service to terminals costing \$100 each;
- (e) multi-purpose space platforms for telecommunications, earth resources and meteorological purposes.

The use of space platforms and higher power satellites for educational purposes was also foreseen as areas where developing countries would also be active participants by the year 2000.

By 2015 (in developed countries), it was foreseen that videophones would be available in perhaps 10% of the homes and that wrist watch "Dick Tracy" communicators working to large space satellites would be available to police, firemen and other specialized personnel. By mid-century it was further expected by a sizable majority that manned missions to other planets, self-sustained permanent space colonies and stations, solar space-power platforms would be in place or under way, and that space communications and applications would have become a significant portion of the world's gross economic product (i.e. 3 to 5%).

Many respondents to the Delphi Survey also expressed concerns about future space and communications activities, such as the militarization of outer space, of global data bases and monitoring systems to check on individuals and their activities. There were also concerns about equitable access to the geosynchronous (or Clarke) orbit and indeed 57% of the respondents believed that current frequency allocations below 50 GHz for space communications could become saturated by 2015. This last prediction, of course, strongly implies heightened "north vs. south" rivalry over access to the geosynchronous orbital arc. In light of the 1979 WARC resolution BP-1, calling for the 1985/87 WARC Conferences to address the issue of equitable access to the geosynchronous orbital arc, these concerns are hardly special or unsuspected insight into the world of international space and communications policy.

A final word on the subject of future predictions as they relate to communications in the third world before we re-enter the world of fact, figures and current reality. The issue of communications development in third world countries is one where predictions are not only difficult, they are also enormously sensitive. In the field of communications development there is a temptation to say what it is hoped will happen and to avoid making projections based upon past results and current trends. The truth of the matter is of course simply this — the needs of the third world for communications development are enormous. There are typically only a few telephones per 100 population in so-called developing countries and in rural and remote areas there is frequently much less than 1 telephone per hundred. The cost of bringing the third world telephone network up to the same standards as Canada or the U.S. would probably exceed \$7 trillion dollars (U.S.).

Mr. Richard Butler, Secretary General of the International Telecommunication Union, has stated many times that a true revolution in telecommunications development would be needed to make a substantial impact on the global village of communications, as shown in Figure No. 1. In short, it seems likely that 5 telephones per 100 or less could still be a typical condition for over half of the world's population even well into the 21st century, unless, and I repeat again for emphasis, unless there is a major breakthrough in worldwide communications development.

Since 1983 is World Communications Year, with world communications development as its theme, it seems relevant to start by highlighting not only the tremendous scope of the needs, but the extent of the revolution required to significantly impact the status quo. In this regard INTELSAT, in particular, has already made a tremendous impact upon the global state of telecommunications. More significantly, I feel it truly possesses the potential to impact in a revolutionary way rural and remote telecommunications development, if it receives the united support of both the industrialized and developing countries alike. Without this united support, it is my personal belief that the ability of developing countries to make dramatic gains in the area of development will be jeopardized. With such support (which I also believe is likely), major advances such as I will outline in the next few minutes can indeed be accomplished.

3. HISTORICAL BACKGROUND

In 1965, three communications satellite systems were established — the United States' initial defense communications system; the Soviet Union's MOLNIYA communications satellite system; and the INTELSAT global satellite system. Of these three systems, only INTELSAT utilized the geosynchronous orbital arc, beginning with the deployment of Early Bird in 1965. Since that time, INTELSAT, as well as the overall field of satellite communications, have both experienced enormous growth, particularly in practical use of the geosynchronous orbit.

The year-by-year development of the INTELSAT System is provided in detail in Figure No. 2. Several aspects of INTELSAT's growth and development, however, deserve special comment:

- (a) First, INTELSAT has largely become the world's overseas telephone, data and television carrier, in that today it provides some two-thirds of the world's total traffic, with most of the remaining one-third of the traffic being carried on submarine cables. Regional and domestic satellite systems carrying international traffic represent a very small portion of the total (the INTERSPUTNIK System traffic level represents only about 0.3% of the traffic volume on the INTELSAT System).
- (b) One of the enormous advantages that the INTELSAT System provides is global interconnectivity. The number of preassigned traffic links between earth stations on the INTELSAT System has grown from 1 to about 1,200, with another 400 demand-assigned links being provided on the SPADE System in the Atlantic Ocean Region. Today, INTELSAT is providing service to nearly 170 countries, territories and areas of special sovereignty around the world.
- (c) INTELSAT is increasingly becoming the option of first choice by developing countries for the provision of domestic satellite services. Today there are some 20 countries utilizing INTELSAT for domestic services and this number is projected to grow to over 40 during the 1980's. Figure No. 3 provides a projection of this growth through 1985.
- (d) INTELSAT, because of the tremendous growth that the global satellite system has experienced for international and domestic services, has itself had to make increasing demands on the geosynchronous orbital arc. Currently, INTELSAT has registered or is seeking to register some 16 orbital positions. These orbital positions are provided in Figure No. 4.

- (e) While INTELSAT's demands on the geosynchronous orbital arc are the largest of any satellite system currently in operation, it should be recognized also that INTELSAT is probably the most effective and efficient user of the geosynchronous orbital arc. This can be objectively measured in a number of different ways, such as relating the number of satellites and orbital positions to such indices as: number of earth station-to-earth station pathways served (currently over 100 international pathways per INTELSAT satellite); number of countries, territories and areas of special sovereignty per satellite (currently over 12 per INTELSAT satellite); efficiency of frequency utilization per satellite (the INTELSAT V and VI satellites respectively create a four-fold and six-fold frequency reuse in the "crowded" C-Band) by employing both polarization discrimination and geographic beam separation. Finally, INTELSAT's historical record, in terms of making more and more effective utilization of orbital locations to increase its effective communications capacity, is remarkable. (The INTELSAT VI, to be launched in 1986, will derive more than 150 times more usable communications capacity from a single orbital arc position than Early Bird.)

4. GLOBAL EXPERIENCE IN THE FIELD OF SATELLITE COMMUNICATIONS (1965-1982)

Parallel to INTELSAT's growth and development has been the worldwide evolution of communications satellite services. From the three satellite systems that emerged on the scene in 1965 an enormous proliferation of satellite systems has occurred. Figure No. 5 provides a current synopsis of more than 120 communications satellite systems, either in service or planned for the mid-to-late 1980's. If the same trend line were to continue at only half of the historical growth — namely, an increase in the number of satellite systems by a factor of 15 every 21 years instead of a factor of 30 experienced so far — then one could project by 2030 there would be some 20,000 communications satellite systems in operation. (Note that figures relate to satellite systems, not satellites.) Such a projection, of course, is theoretical nonsense. Nevertheless, the current trend line of exponential growth in satellite communications suggests several things. Namely, that the proliferation of satellite systems is a very strong and powerful trend and that the burgeoning demand for new and higher volume of communications satellite services puts enormous stresses on the geosynchronous orbital arc for everyone to make more effective use of this resource.

While the experience to date, in terms of increases in the effective communications capacity derived from the geosynchronous orbital arc represented by the 21-year span between Early Bird and INTELSAT VI is

encouraging, there are technical reasons to conclude that to make comparable increases from INTELSAT VI to say INTELSAT X will require massive expenditures of R&D; a possible need to consolidate multiple missions; larger and more complex satellite networks, either in the form of space platforms or clusters of smaller satellites linked with inter-satellite links; more cost-efficient launch vehicle technology; and considerable progress in modulation, coding and on-board signal processing techniques. It is likely that policy and institutional problems in this regard may prove much more difficult than those of satellite and launch vehicle technology.

5. THE INSTITUTIONAL ENVIRONMENT

The growth of communications satellite services has given rise to a variety of new institutional arrangements, as well as reshaping of some existing institutions. The International Telecommunication Union's structure, including the ITU, the IFRB, the CCIR, CCITT and the World Plan structure, all play an important regulatory and policy role in the use of geosynchronous communications satellite services for a wide variety of applications, including fixed satellite services; broadcast satellite services; land, maritime and aeronautical mobile services; military communications services; community antenna television services for educational purposes; data relay, etc.

The INTELSAT Agreement, upon which the INMARSAT and EUTELSAT Agreements are closely patterned, provide certain provisions for effective intersystem coordination of the various communications satellite systems. The growth of domestic and regional satellite systems, plus demand for new services beyond conventional Fixed Satellite Services (FSS), particularly Broadcast Satellite Services (BSS), mobile services and military services, will make it increasingly difficult to achieve technical coordination in an environment where there is more and more interference between various satellite services. In addition, there is also the issue of economic coordination as well, although the "economic harm" provisions of Article XIV(d) of the INTELSAT Agreement have never been invoked to create a negative finding concerning the creation of other satellite systems, even though the recently concluded Seventh INTELSAT Assembly of Parties did restrict its favorable findings on the EUTELSAT System and the U.S. and Canadian transborder use of domestic satellites to only a five-year period, rather than the ten years requested.

From an institutional or policy perspective, INTELSAT has adopted a positive strategy of trying to duplicate or better the offerings of potentially competitive systems whenever and wherever possible and has also tried to be responsive to all of its Signatories' needs, in terms of providing an increasingly reliable and cost-effective service. The strategy of trying to prohibit regional satellite systems from a defensive posture has generally been considered by INTELSAT's membership to be essentially unworkable. Nevertheless, the provisions of Article XIV(d), in terms of economic harm, have presented increasingly more difficult issues for the INTELSAT organization and its strategy for trying to maintain the integrity of a global satellite system in an environment of potential proliferation of regional satellite systems, is a major and largely unanswered

question. Certainly INTELSAT's response to satellite proliferation is a particularly challenging assignment in an environment of deregulation and of emerging regional industrial interests.

6. INTELSAT'S PLANS FOR THE FUTURE

The future of satellite communications for the next 20 years will be characterized by dynamic change as a consequence of: (a) the burgeoning of wideband communications service requirements; (b) the expanding range of satellite services being offered (e.g., direct broadcast services; land, air and maritime mobile services; and rural, thin-route services); (c) the advent of fiber optic technologies; (d) the emergence of regional satellite systems; (e) the emergence of new technologies that will in turn allow lower cost launch service, to allow greater reuse of frequencies; to allow closer spacing of satellites; and to allow greater communications capacities at a single orbital location (e.g., digital compression and processing techniques). INTELSAT expects to play an important part in this future of change and innovation in a number of different ways.

6.1 TECHNOLOGICAL DEVELOPMENT

First, INTELSAT has been one of the leading innovators in the field. INTELSAT's R&D and its satellite procurement programs have played key roles in developing frequency reuse through polarization discrimination and beam separation; in developing digital communications and digital speech interpolation; in developing satellite switching and the future use of on-board signal processing; and in developing more reliable longer life satellites. INTELSAT, through its R&D programs and through cooperative projects with such organizations as NASA and ESA, will likely pioneer in a number of important satellite technologies for the 1980's and 1990's, particularly in the development of larger multi-purpose satellites that will allow the most efficient possible uses of the geosynchronous orbital arc.

6.2 EXPANDED DOMESTIC SERVICE OFFERING

INTELSAT provides domestic satellite services to some 20 countries today, and the number is expected to double in the next five years. For every country that decides to launch and deploy its own domestic satellite system, probably three will decide to lease space segment capacity for domestic services because this is by far the most cost-effective answer for countries with only small amounts of traffic. INTELSAT is the supplier of first choice for domestic services for a number of reasons: (a) INTELSAT's cost is low (\$800,000 per global beam transponder per year); (b) INTELSAT is reliable (preemptible service has never been preempted); (c) INTELSAT's offering is flexible;* (d) INTELSAT is

* One can obtain space segment in increments as small as one-quarter of a transponder. Indeed, one can also obtain global beam, hemi-beam and spot beam transponder service. 72 MHz wide band transponders can deliver power for thin-route services in the range of 30-32 dBW. In the future, additional service offerings from INTELSAT can be anticipated.

universally trusted and provides equitable financial arrangements. (Many countries who would be unwilling to entrust their international and domestic service requirements to a private concern, another country or a political agency, have learned they can trust INTELSAT to provide an effective, reliable, non-political service that is fair, responsive and technically competent.); and (e) The financial arrangement that allows use and investment to always be in balance is seen as just and equitable.

No other entity is likely to be able to substitute for INTELSAT's role as a "quasi-guarantor" of equitable access for domestic communications satellite services, whether they be developed or developing countries.

6.3 RESPONDING TO REGIONAL NEEDS

INTELSAT, in its studies and system planning, is currently actively exploring how it can better respond to regional concerns as well. In particular, it would seem that domestic leased services might be offered to a "contained" or "closed" system, composed of Southwest Pacific island countries as a "quasi-domestic service." In the South Pacific region, one-quarter to one-half of a global beam transponder can provide effective and low cost service for perhaps initially some forty 5-meter earth stations, even though a "star" system must be employed to achieve full interconnectivity in the region and a double hop satellite connection via a Standard A or B earth station will be required for access to the global network.

An extension of this or similar concepts could ultimately become possible in other developing regions of the world, such as Africa. This approach or strategy, however, will mean that INTELSAT should move to provide higher powered land mass oriented satellite capability as soon as possible.

Another option that is under study by INTELSAT is that of separately financing space segment for regional or other defined services under the broad umbrella of the INTELSAT Organization or a subsidiary unit and, in particular, under the provisions of Article III(e) of the INTELSAT Agreement, which reads as follows:

"INTELSAT may, on request and under appropriate terms and conditions, provide satellites or associated facilities separate from the INTELSAT space segment for:

"(a) domestic public telecommunications services in territories under the jurisdiction of one or more Parties;

"(b) international public telecommunications services between or among territories under the jurisdiction of two or more Parties;

"(c) specialized telecommunications services, other than for military purposes;

"provided that the efficient and economic operation of the INTELSAT space segment is not unfavorably affected in any way."

6.4 Multi-Purpose or Multi-Owner or Multi-Mission Satellite Programs or Services

As economies of scale and the desire to maximize the efficient use of the geosynchronous orbital arc drive future satellite programs in the direction of space platforms or multi-mission satellites, the institutional flexibility of INTELSAT and the proven track record of INTELSAT as a reliable provider of complex, multi-user satellites, will likely be increasingly recognized as an important international asset. More succinctly, INTELSAT is a logical way for multi-mission, cost-effective space platforms to become a reality, and thus allow all countries of the world, both developed and developing, to enjoy the benefits of the world's most advanced space technology.

7. FINAL COMMENTS AND CONCLUSIONS

The above brief discussion of INTELSAT's plans for the future strongly indicates that INTELSAT can and likely will play an important future role in driving down the cost of communication services, in stimulating space platform technology, in making more effective use of the geosynchronous orbital arc, in aggregating domestic and, in the future, regional satellite system service requirements, in providing new and previously unmet international communications service demands, and in relieving international pressures to alter in a dramatic way the "first-come, first served" principle for access to the geosynchronous orbital arc. As such, INTELSAT is an important international resource of great value and practical benefit to the entire world.

In the coming decades, developing countries will increasingly employ satellite technology together with terrestrial technologies to try to move dramatically forward, with not only telecommunications development but economic development as well. The International Telecommunication Union's microeconomic studies in Kenya, Egypt, and the South Pacific, already have strongly indicated that telecommunications development is a remarkably strong stimulus for economic development. Realistic goals for the 1980's, such as a public call box within five miles of every human settlement and a basic workable telecommunications network in every country, need to be extended to truly visionary goals for the 21st century. Certainly, in the 21st century we should be able to use modern technologies and human resources to achieve universal education, worldwide industrialization, and decent standards of living. Consequently, these technologies could also be used for environmental and cultural preservation as well. It would be a tragic result if a large part of these ambitious goals for the 21st century were to become bogged down by fruitless "north vs. south" disputes over plans for exploitation of the geosynchronous orbital arc based upon narrow industrial or national interests.

The true global needs of all humanity, of developed and developing countries alike, need to be developed on a collective basis. There are many formulas that might be devised to achieve a global strategy for the equitable use of the geosynchronous orbit, but the principles are actually quite straight-forward and practical. These principles include the following basic points:

- (a) national, regional, and global needs and interests must all be clearly recognized and accommodated;
- (b) development of new satellite modulation and earth terminal equipment technology must move ahead rapidly to respond to new demands and new services. Research with regard to the use of higher radio frequencies and space platforms can only be accomplished in an environment wherein extensive, high cost R&D is rewarded and financial incentives exist to pursue these new technologies;
- (c) transition policies concerning the introduction of new technologies that involve new or retrofitted equipment in space or on the ground must be well planned, gradually implemented and not unduly expensive, particularly when they concern developing countries;
- (d) all countries, regardless of their levels of economic development, should be able to participate in the advantages of satellite communications and space applications, either with their own systems or through a leased or shared-use satellite system;
- (e) the overall approach must be economically viable, as well as equitable to all countries.

It seems entirely possible, given the history of international telecommunications diplomacy, that these broad principles can be accommodated and that the equitable solutions for all countries of the world, as well as for all regional and international entities directly involved in telecommunications, can indeed be found. If not, the visionary goals of a better and brighter 21st century for all mankind will be eroded and perhaps even lost. Personally, I feel the future of global communications is both bright and hopeful.

Figure No. 1
**GLOBAL VILLAGE
1981**

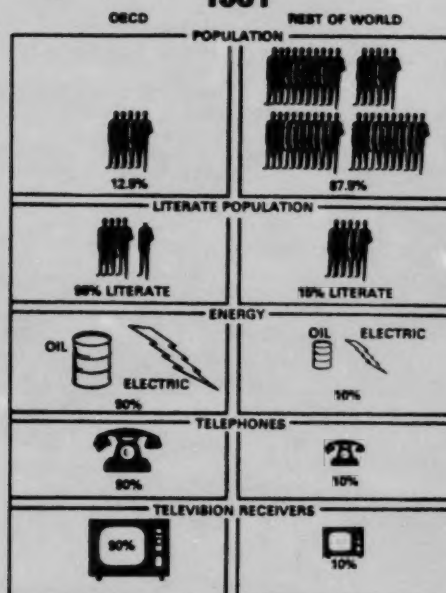


Figure No. 2

**YEAR-BY-YEAR HISTORY OF INTELSAT DEVELOPMENT
(1966-1973)**

	1966	1966	1967	1968	1969	1970	1971	1972	1973
Total number of countries territories or possessions served by INTELSAT (directly & indirectly)	15	15	22	25	52	60	77	93	100
Number of Earth station-to-earth station pathways	1	1	10	19	82	131	181	255	293
Total number of half circuits	150	172	688	1,142	2,835	4,259	5,822	7,497	9,814
Hours of television	80	152	450	1,372	1,826	2,428	3,562	6,792	6,817
SPADE usage (billable minutes)	—	—	—	—	—	—	—	—	135,330
Circuit restoration (half circuit days)	36	598	2,284	7,428	14,722	19,005	29,822	36,428	39,866
Earth station-to-earth station continuity of service	—	—	—	—	—	—	—	99.870%	99.875%
Total system capacity (voice circuits plus television, SPADE capacity not included)	240 or 1 TV	240 or 1 TV	480 or 2 TV	2,400 plus 4 TV	3,600 plus 6 TV	4,800 plus 8 TV	10,400 plus 8 TV	16,000 plus 8 TV	16,000 plus 8 TV
Number of countries leasing capacity for domestic services	—	—	—	—	—	—	—	—	—
Annual space segment utilization charge (\$US)	32,000	20,000	20,000	20,000	20,000	20,000	15,000	12,960	11,160
Net investment in INTELSAT space segment (\$US 000)	—	—	69,263	85,792	122,498	131,497	232,122	235,901	258,049

**YEAR-BY-YEAR HISTORY OF INTELSAT DEVELOPMENT
(1974-1982)**

	1974	1975	1976	1977	1978	1979	1980	1981	1982 *
Total number of countries, territories or possessions served by INTELSAT (directly & indirectly)	107	107	115	122	132	141	154	164	164
Number of Earth station-to-earth station pathways	359	406	491	558	646	757	840	976	1,045
Total number of half circuits	11,507	13,369	16,520	20,199	25,293	32,423	40,609	50,244	60,800
Hours of television	7,361	7,887	12,952	15,193	23,293	20,770	28,392	35,658	52,100
SPADE usage (billable minutes)	3,439,375	5,711,539	16,235,239	29,879,918	38,453,732	36,306,450	28,010,780	39,333,988	44,400,000
Circuit restoration (half circuit days)	41,888	23,060	17,352	26,254	24,626	55,234	43,740	40,364	20,000
Earth station-to-earth station continuity of service	99.889%	99.892%	99.876%	99.904%	99.877%	99.883%	99.893%	99.927%	99.900%
Total system capacity (voice circuits plus television, SPADE capacity not included)	16,000 plus 8 TV	16,000 plus 8 TV	20,000 plus 8 TV	20,000 plus 8 TV	20,000 plus 10 TV	25,500 plus 10 TV	25,500 plus 10 TV	36,000 plus 10 TV	40,000 plus 10 TV
Number of countries leasing capacity for domestic services	2	4	6	12	15	16	15	18	24
Annual space segment utilization charge (\$US)	9,000	8,460	8,280	7,380	6,840	5,760	5,040	4,680	4,680
Net investment in INTELSAT space segment (\$US 000)	291,358	334,950	351,618	399,332	436,931	523,462	672,501	852,003	1,076,000

* Projected

Figure No. 3

GROWTH OF INTELSAT DOMESTIC TRANSPONDER LEASES

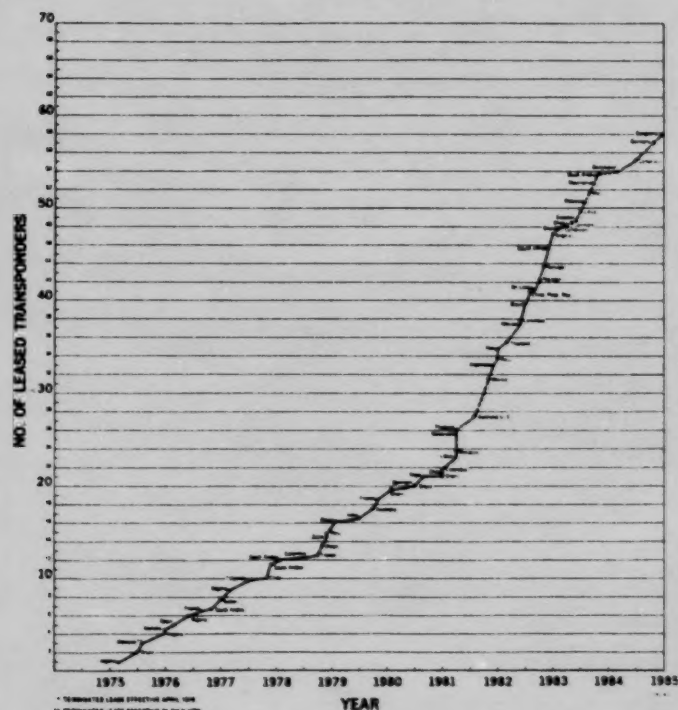


Figure No. 4

INTELSAT SATELLITE LOCATIONS REGISTERED OR TO BE REGISTERED WITH THE IFRB

Location	Satellite Type				Frequency Bands	
307.0°E	IV	IVA	V	VA	6/4 GHz	14/11 GHz
310.0°E	IV	IVA	V	VA	6/4 GHz	14/11 GHz
325.5°E	(IV)	(IVA)	V	VA	6/4 GHz	14/11 GHz
329.0°E		IVA			6/4 GHz	
332.5°E		(IVA)	V	VA VI	6/4 GHz	14/11 GHz
335.5°E		(IVA)	V	VA VI	6/4 GHz	14/11 GHz
338.8°E	(IV)	(IVA)	V		6/4 GHz	14/11 GHz
341.5°E	(IV)	(IVA)	V	VA	6/4 GHz	14/11 GHz
356.0°E	IV	IVA			6/4 GHz	
359.0°E	(IV)	IVA	V	VA	6/4 GHz	14/11 GHz
57.0°E	(IV)	IVA	V	VA VI	6/4 GHz	14/11 GHz
60.0°E	(IV)	(IVA)	V	VA VI	6/4 GHz	14/11 GHz
63.0°E	(IV)	(IVA)	V	VA	6/4 GHz	14/11 GHz
66.0°E	IV	IVA	V	VA	6/4 GHz	14/11 GHz
174.0°E	(IV)	IVA	V	VA	6/4 GHz	14/11 GHz
179.0°E	(IV)	IVA	V	VA	6/4 GHz	14/11 GHz

() = Registration that will no longer be required by 1983.

Figure No. 5

GLOBAL SATELLITE SYSTEM GUIDE

1. INTERNATIONAL SATELLITE SYSTEMS

	Members	Current Status
1.1 INTELSAT Global Satellite System	106 members	Operational (currently 16 satellites)
1.2 INMARSAT Maritime Mobile Satellite System	37 members	Operational (4 satellites)
1.3 INTERSPUTNIK Satellite System	12 members	Operational (leased capacity from USSR)

2. REGIONAL SATELLITE SYSTEMS

	Members	Current Status
2.1 ArabSat Satellite System	18 members	1985 launch
2.2 African Satellite System	Most African Nations	Under consideration only.
2.3 EUTELSAT Satellite System	Most European Nations	To be fully operational 1983/84.
2.4 Palapa Satellite System	Asian Countries	Indonesia Domestic System, regional services to Asian members - Operational

3. DOMESTIC SATELLITE SYSTEMS - DEDICATED SYSTEMS

	Services	Current Status
3.1 Australian National Satellite Systems (AUSATSAT)	FSS, CATV, DBS	Under construction for 1985 launch.
3.2 Brazilian Domestic Satellite System (BRAZILSAT)	FSS, DBS, Domestic	Under construction for 1985 launch.
3.3 Canadian Domestic Satellite System (ANIK A-D)	service to U.S.	Operational
3.4 China Domestic Satellite System	FSS	Project cancelled.
3.5 Colombia Domestic Satellite System (Satcol)	FSS	Contract award under consideration.
3.6 French Dom. Digital Satellite System (Telecom)	FSS	Under construction for 1985 launch.
3.7 French DBS Satellite (T.D.F.)	DBS	Under construction for 1986 launch.
3.8 Germany (Fed. Rep. of) Domestic Digital and TV Distribution Satellite	FSS	Planned for 1987 or 1988.
3.9 Germany (Fed. Rep. of) DBS Satellite (TV-Sat)	DBS	Planned for 1986.
3.10 Indian Satellite System (INSAT)	FSS, DBS	Operational (temporarily out of service).
3.11 Indonesian Satellite System (Palapa A & B)	FSS	Operational
3.12 Iranian Satellite System (Sahreh)	FSS	Project cancelled
3.13 Italian Satellite System (Italsat)	DBS	Planned for 1986.
3.14 Italian DBS Satellite System (SARIT)	FSS	Planned for 1985.
3.15 Japanese Domestic Satellite System (DS-2a, 2b)	DBS	Planned for 1983.
3.16 Japanese Domestic Broadcasting System (LUXSAT)	DBS	Planned for 1985.
3.17 Luxembourg Domestic Satellite System (SATHEX)	DBS	Planned for 1986.
3.18 Mexican Domestic Satellite System (SABS)	DBS	Status uncertain.
3.19 Saudi Arabian Broadcast Satellite System (Tele-X)	FSS, DBS, Mobile	Planned for 1986.
3.20 Swedish Domestic Satellite System (Nalveasat)	DBS	Planned for 1986.
3.21 Switzerland Domestic B-coast Satellite (UNISAT)	DBS, FSS	Planned for 1986.
3.22 United Kingdom Domestic Satellite Systems		
3.23 United States Domestic Satellite Systems	FSS, DBS	Planned for late 1980's.
3.23.1 Advanced Business Communications, Inc. (ABC1)	FSS	Operational.
3.23.2 American Satellite Company System	FSS	Operational.
3.23.3 Comstar Satellite System	DBS	Planned for mid-1980's.
3.23.4 CBS Satellite System	DBS	Planned for mid-1980's.
3.23.5 Direct Broadcast Satellite Corporation	DBS	Planned for mid-1980's.
3.23.6 Graphic Scanning Satellite System	FSS, DBS	Planned for 1984.
3.23.7 GTE Satellite System (G-Star)	FSS	Planned for 1983.
3.23.8 Hughes Galaxy Satellite System	DBS	Planned for mid-1980's.
3.23.9 Oak Satellite System	DBS	Planned for mid-1980's.
3.23.10 RCA DBS Satellite System	FSS	Operational.
3.23.11 RCA Satcom Satellite System	FSS	Operational.
3.23.12 Satellite Business System (INB/Comsat)	FSS	Planned for 1985.
3.23.13 Southern Pacific Communications Corp. (SPACNET)	DBS	Planned for 1985.
3.23.14 Satellite Television Corp. (Comsat)	FSS	Planned for 1984.
3.23.15 Telstar Satellite System (AT&T)	Data relay, FSS	Planned for mid-1983.
3.23.16 Tracking, Data, Relay Satellite/Advanced Westar (NASA/Western Union)	DBS	Planned for mid-1980's.
3.23.17 United Satellite Services Broadcasting (Hubbard)	FSS	Planned for mid-1980's.
3.23.18 U.S. Satellite System, Inc.	DBS	Planned for mid-1980's.
3.23.19 Video Satellite System	FSS	Operational.
3.23.20 Western Union Satellite System	DBS	Planned for mid-to-late 1980's.
3.23.21 Western Union DBS Satellite System		
3.24 U.S.S.R. Domestic Satellite Systems	TV, DBS	Operational
3.24.1 Ekran Broadcast Satellite System	FSS	Operational
3.24.2 Loutch Satellite System	FSS	Operational
3.24.3 Molnya Satellite System	FSS, Military	Operational
3.24.4 Raduga Satellite System	Maritime Mobile Ser.	Planned for 1984.
3.24.5 Volna Satellite System		

4. DOMESTIC SATELLITE SYSTEMS - (Leased/Shared Use Systems)

	Space Segment Facilities	Current Status
4.1 Algerian Satellite System	INTELSAT Lease	Operational
4.2 Angolan Satellite System	INTELSAT Lease	Planned for 1983
4.3 Argentina Satellite System	INTELSAT Lease	Operational
4.4 Australia Satellite System	INTELSAT Lease	Operational
4.5 Bangladesh Satellite System	INTELSAT Lease	Planned for 1984.
4.6 Bolivian Satellite System	INTELSAT Lease	Planned for 1983.
4.7 Brazilian Satellite System	INTELSAT Lease	Operational
4.8 Cameroon Satellite System	INTELSAT Lease	Planned for 1984
4.9 Chilean Satellite System	INTELSAT Lease	Operational
4.10 China Satellite System	INTELSAT Lease	Planned for 1983
4.11 Colombian Satellite System	INTELSAT Lease	Planned for 1983
4.12 Denmark (Greenland) Satellite System	INTELSAT Lease	Operational

Figure No. 5

Page 2

GLOBAL SATELLITE SYSTEM GUIDE

4. DOMESTIC SATELLITE SYSTEMS - (Leased/Shared Use Systems)

	Space Segment Facilities	Current Status
4.1 Algerian Satellite System	INTELSAT Lease	Operational
4.2 Angolan Satellite System	INTELSAT Lease	Planned for 1983
4.3 Argentina Satellite System	INTELSAT Lease	Operational
4.4 Australia Satellite System	INTELSAT Lease	Operational
4.5 Bangladesh Satellite System	INTELSAT Lease	Planned for 1984.
4.6 Bolivian Satellite System	INTELSAT Lease	Planned for 1983.
4.7 Brazilian Satellite System	INTELSAT Lease	Operational
4.8 Cameroon Satellite System	INTELSAT Lease	Planned for 1984
4.9 Chilean Satellite System	INTELSAT Lease	Operational
4.10 China Satellite System	INTELSAT Lease	Planned for 1983
4.11 Colombian Satellite System	INTELSAT Lease	Planned for 1983
4.12 Denmark (Greenland) Satellite System	INTELSAT Lease	Operational
4.13 Ecuadorian Satellite System	INTELSAT Lease	Planned for 1983
4.14 France Overseas Territory (Reunion, Martinique) Satellite System	INTELSAT Lease	Operational
4.15 Germany (Fed. Rep. of) Satellite System	INTELSAT Lease	Planned for 1984
4.16 Spot Beam 14/11 GHz Indian Satellite System	INTELSAT Lease	Operational
4.17 Korean (Rep. of) Satellite System	INTELSAT Lease	Planned for 1986
4.18 Libyan Satellite System	INTELSAT Lease	Operational
4.19 Malaysian Satellite System	INTELSAT Lease	Operational
4.20 Mali Satellite System	INTELSAT Lease	Planned for 1983
4.21 Mauritanian Satellite System	INTELSAT Lease	Planned for 1983
4.22 Mexican Satellite System	INTELSAT Lease	Operational
4.23 Moroccan Satellite System	INTELSAT Lease	Operational
4.24 Niger Satellite System	INTELSAT Lease	Operational
4.25 Nigerian Satellite System	INTELSAT Lease	Operational
4.26 Norwegian Satellite System	INTELSAT Lease	Operational
4.27 Oman Satellite System	INTELSAT Lease	Operational
4.28 Pakistan Satellite System	INTELSAT Lease	Planned for 1983
4.29 Papua New Guinea Satellite System	AUSSAT/INTELSAT lease	Planned for 1985
4.30 Peruvian Satellite System	INTELSAT Lease	Operational
4.31 Philippine Satellite System	INTELSAT/Palapa lease	Operational
4.32 Portugal (Azores) Satellite System	INTELSAT Lease	Operational
4.33 Saudi Arabia Satellite System	INTELSAT Lease	Operational
4.34 South Africa Satellite System	INTELSAT Lease	Planned for 1983
4.35 Spain (Canary Islands) Satellite System	INTELSAT Lease	Operational
4.36 Sri Lanka Satellite System	INTELSAT Lease	Planned for 1985
4.37 Sudan Satellite System	INTELSAT Lease	Operational
4.38 Thailand Satellite System	INTELSAT Lease	Planned for 1983
4.39 United Kingdom (Offshore Service) Sat. System	INTELSAT Lease	Planned for 1983
4.40 Venezuelan Satellite System	INTELSAT Lease	Planned for 1983
4.41 Zairian Satellite System	INTELSAT Lease	Operational

5. MILITARY SATELLITES SYSTEMS

	System Names	Current Status
5.1 NATO Military Satellite Communications Project	Phase I, II, III	Operational
5.2 U.K. Skynet Defense Communications Network	SKYNET	Operational
5.3 U.S. Military Satellite Communications Network		
5.3.1 U.S.A.F. Communications Satellite System	AFSATCOM	Operational
5.3.2 U.S. Defense Satellite Communications System	DISCS Phase I, II, III	Operational
5.3.3 U.S. Naval Satellite Communications System	Marisat/Leasat	Operational
5.3.4 U.S. FleetSatcom Communications System	FLTSATCOM	Operational
5.4 U.S.S.R. Military Communications Satellite System		
5.4.1 Cosmos Military Satellite System	Cosmos	Operational
5.4.2 GALS Military Satellite System	Gals	Operational
5.4.3 Volna Naval Communications Satellite System	Volna	Planned 1984

6. EXPERIMENTAL SATELLITE SYSTEMS

	Sponsors	Current Status
6.1 Applications Technological Satellites	U.S. NASA	Operational
6.2 Canadian Experimental Mobile Satellite Program	Canadian Govt	Planned for 1988
6.3 Communications Technology Satellite	U.S./Canada	Out of service
6.4 European Mobile Communications Satellite	E.S.A.	Planned for 1987
6.5 Japanese Experimental Broadcast Satellite	NASADA (GE)	Planned for 1987
6.6 Japanese Experimental Communications Satellite	NASADA (FACC)	Operational
6.7 Lincoln Experimental Satellite Project	U.S. DOD	Out of service
6.8 U.S. Mobile Satellite Experiment Program	NASA	Planned for late 1980's
6.9 NASA Advanced Technologies Satellite Experiment	20/30 GHz	Planned for late 1980's
6.10 NASA Experimental/Prototype Space Platform		Planned for late 1980's
6.11 Orbital Test Satellite	ESA Experimental Sat.	Operational
6.12 Sirio Experimental Communications Satellite	Italian	Operational
6.13 Symphonie Experimental Communications Satellite	French/German	Operational
6.14 TACSATCOM Experimental Military Satellite	U.S. Military	Out of service

THE ECONOMICS OF TRANSBORDER DATA FLOWS

Meheroo Jussawalla and Chee-Wah Cheah
East-West Center
Honolulu, Hawaii

Abstract

The phenomena of transborder data flows have emerged from rapid technical changes in the area of computer communications. Attendant upon this, new economic opportunities are inducing institutional changes designed to modify the manner in which economic gains are to be partitioned. This has, in turn, led to government actions that go beyond conventional allocative and redistributive roles of governmental intervention. This paper discusses some of the welfare implications of "protectionism" that have appeared on the international scene. By so doing we may begin to anticipate and perhaps circumvent the economic inefficiencies of barriers to trade involving data flows.

1. INTRODUCTION

Transborder data flows (TBDF) are not novel phenomena per se, but have assumed increasing importance in the context of a rapidly growing services sector in the balance of payments accounts of industrialized countries. The conventional measurement of the output of the services sector is done in terms of wages and salaries for both producer services and consumer services. Accounting practices however tend to underestimate the value-added contribution to gross national product by the services sector, e.g., the producer information services that form part of agriculture, manufacturing, and construction. As human capital becomes an increasing critical input of economic growth, communication technology increases the output of skilled manpower through its information processing and distributing capacity.

As a corollary to this growth in the contribution of human capital to GNP, improvements in communication technology have resulted in the formation of corporations for providing information services which span continents in their organizations and which contribute to gains from export trade. Those who advocate the "reindustrialization" of First World countries tend to overlook the fact that the services sector is growing so rapidly that even with reindustrialization, the manufacturing sector may not expand concomitantly. Strange as it may sound to those of us who see personal computers and their software packages all around us, a technology lag is predicted by the System Dynamics Group from the Massachusetts Institute of Technology (*Business Week* October 11, 1982). Based on this study, industrialized countries are on the downturn of the Kondratieff cycle, a theory which explains long waves of business growth and decline. The reason, as seen by the MIT economists, is that the new technologies like computers, microchips, biogenetics are all infant industries

in respect of their impact on employment and economic growth. For these industries to create a boom will require a number of breakthroughs leading to more innovative new industries and not just increases in the productivity of existing ones. If we go along with this thesis, it becomes obvious that these new infant industries should receive protection in international trade as did other similar industries in the past.

Transborder data flows emerge from the combination of computers and telecommunication industries which are gradually displacing the smokestack industries. As such, reindustrialization in a post-industrial age will come not from shoring up existing traditional industries, but by government intervention in long range investment in and protection of the new structure of emerging infant industries. These new growth industries need time to give the kind of spread effects envisaged in Schumpeter's theory of innovations. But during this time lag innovations in communication technology both in conduit and in content need greater flows of investment and some measure of protective tariffs. As employment in the services sector continues to accelerate in contrast to the declining trend in the industries sector, a breakdown of these services into information and non-information activities becomes possible. The current growth in business services is an outcome of employment in information-copying, data processing, mailing, and other technological changes that reinforce the trend for greater division of labor.

A shrinking agricultural base combined with a stagnating industrial superstructure are equally characteristic of Newly Industrializing Countries (NICs) as of their OECD trading partners. Growth in the services sector of the NICs is overtaking growth in the industrial sector, shifting their pattern of investment and altering their strategy for development. Informatics services are fast

catching on in these countries and World Bank indicators (1982) reveal that their growth has not followed the historic pattern enunciated in economic growth theories of the fifties. In a study of the economy of Singapore (Jussawalla and Cheah, 1981) it was found that two-thirds of the country's total output is generated through services and over 35 percent of these services were devoted to the production and distribution of information. The primary information sector in Singapore contributes over 24 percent of Gross Domestic Product.

Against the background of technological changes which expand international trade, we will examine the economic aspects of information flows both at the international and intercorporate levels with special reference to the generation of such flows by transnational corporations. In this context we will analyze the visible changes in the perception of governments regarding the significance of information resources which has led to actions that go beyond conventional allocative and redistributive policies of government intervention. Using the analytical tools of economics it is possible to look at information flows as akin to primary goods exports from developing countries which call for a greater balance in international information flows and greater equity in access to information resources across national borders. In the course of this paper, we present the impact of the structural transformation of economic systems caused by the communication revolution on their trade and payments balances in an attempt to estimate to what extent barriers to data flows are virtually barriers to trade. While there are economic theories covering international trade, public choice, and government policy, we have no economic theory that examines the international flow of data. It is important to obtain insights regarding the policy options and policy preferences that are available both to developed and developing countries, so that decision-makers will be equipped to arrive at investment decisions which will generate future growth in trade and higher economic development.

2. WHAT ARE TRANSBORDER DATA FLOWS?

TBDF is an emerging phenomenon in international communications associated with the fusion of modern computer and telecommunications technologies which has resulted in a proliferation of international computer generated information. Its significance lies in the potential gains and economic opportunities arising from technical and institutional changes consequent to the growing interface between computers and telecommunications. Its operations require a recognition of the economic dimensions of international relations. It involves the international regime of laws, regulations, and practices that are emerging from such data flows and the institutional changes which governments will face in sorting out potential conflict situations.

Essentially TBDF signifies "units of information coded electronically for processing one or more digital computers which transfer or process the

information in more than one nation state" (Novotny 1980). International trade has always relied on information flows for estimating import and export elasticities and to determine prices, quantities, and currency rate exchanges. However, computer readable information has speeded up the process of information exchange leading to more rapid settlement of contracts in trade along with more timely and accurate projections of international market trends. In the fifties the travel industry and national defense agencies expanded the use of computer networks. In the next decade transnational corporations rapidly relied on TBDF along with banks, financial, and educational institutions. Through the seventies there has been a replacement of traditional telephone networks by computer communications. The result has been a "real-time" coordination of economic activities on a global scale. The increased decentralization of information-intensive industries like banking, insurance, tourism, and transportation have intensified the demand for instantaneous availability and transmission of information. These industries are found mostly in the services sector which relies on information storage, retrieval and up-dated systems that are accessible on an on-line basis for efficient corporate performance. Such elaborate information support systems are established as closed user-group networks that service the demands of subscribers. One major system of this kind exists in the international financial community wherein member banks and other financial institutions can access services provided by the Society for Worldwide Interbank Financial Telecommunication (SWIFT). Another similar system vital to the airline industry is the Societe Internationale pour la Telecommunication Aeronotique (SITA).

TBDF also takes place through the commercial marketing of information contained in data bases. By using the existing communications infrastructure, computer service bureaus are able to provide access to their sophisticated hardware for time-shared data processing and data base information retrieval. These data bases provide economies of the leverage of specialization by centralizing data location and saving on costs of generation, verification and updating of duplicate data bases. This advantage is reinforced by the declining costs of telecommunication which facilitate such centralized storage and retrieval. Industrial output trends, securities sales, foreign exchange fluctuations, commodity exchange trends, technology patents, and satellite remote-sensing data (to a limited extent) are all available on data bases.

Therefore TBDF depends for its success on the infrastructure through which transmissions can be effected. At the national level the common carriers provide the infrastructure. Where countries are geographically contiguous, these common carriers are linked with each other and facilitate data flows across political boundaries. For transoceanic traffic, the infrastructure is extended by bilateral agreements which permit interconnections through submarine cables and satellite links among common carriers. In addition to these traditional

networks, there are also "dedicated" networks created by users who lease lines from common carriers. Combining these leased lines with computer equipment, these value-added carriers further enhance the cost-effectiveness of telephone networks for data transmission purposes. Examples of value-added networks (VANS) include the publicly-owned EURNET and the privately-owned TELENET and TYMNET.

In economic terms there is a point-to-point exchange of proprietary information based on contractual relationships. The commercial application of the interface between computers and telecommunications is essentially in the packaging of information which is increasingly treated as an economic good. Telecommunications serve primarily as a medium for remote access and distribution of processed data (Irwin 1969). The economic value of such services derive from the benefits emerging from a combination of information with the technology of electronic processing, storing, and communicating. These benefits are associated with the growth of a new and unique computer-based service industry.

In the United States total domestic revenues of information data services rose from \$2 billion in 1970 to \$8 billion in 1978. International revenues from the same services increased from \$300 million in 1972 to over \$800 million in 1978. In terms of international trade, the world market for data processing systems (which include computers, peripherals, and related services) amounted to \$50 billion in 1980. This market is expected to grow at an annual rate of 17 percent. At the same time, the market for telecommunications equipment is estimated at \$30 billion with an annual growth rate of 8 percent (Pearce 1980).

The incomes generated by TBDF are increasing, but so far the regulations governing trade in merchandise have not been extended to data flows. This is likely to change as the contribution of these exchanges to balance of payments assumes significant importance. The reason for this change is the application of a technology that is synergetic in its impact and difficult to differentiate from a production function point of view. For example, the technology is convergent not just because of the merger of computers with telecommunications (telematics as it is termed) but it is convergent because information technology has become an integral part of the production system of other manufacturing industries be they automobiles, aircraft, steel, or metropolitan railroad systems. Even financial institutions and security exchanges are converging with information technology creating wider and newer markets, and new patterns in the value and volume of international trade. Therefore, as international trade grows in complexity based on convergence of technology and production systems, global concern is being expressed regarding the future trading prospects of both industrialized and developing countries. The latter feel threatened by a repetition of historical trading patterns which when projected in an age of computer communications may relegate them to providers

of primary data and importers of sophisticated information systems (see Dordick 1981).

TBDF are, in one respect, similar to conventional trade inasmuch as an asset of value is moved across borders. But the consequences of this movement are in economic terms intangible. The conflict of measuring these flows stems from the fact that the conduit has to be distinguished from the content and each is separately priced and traded. The content does not have a palpable physical construct which can be recorded or accounted for or monitored by conventional accounting practices. It is not possible to estimate the production possibility curves for TBDF and specifically state if such flows have resulted in mutual benefits post-trade compared with pre-trade conditions. For example, a country from which raw data is exported without being invoiced receives no reimbursement for costs of collecting and handling that data, but which when processed will create employment and value-addition in the importing country. This "undetectability" of TBDF creates opportunities along with problems of control, for fraud, misuse and flight of profits (Madec 1980).

3. TRANSNATIONAL CORPORATIONS AND THE CONTROL OF TBDF

The oligopolistic structure of the international data market led to a special study on TBDF by the United Nations Center on Transnational Corporations (UNCTC Report, July 1982). TNCs play a major role in the expansion and utilization of data flows across countries. They provide the hardware, software, and communication links. Value-added networks specifically dedicated to data transmission offer an expanding transnational infrastructure for TBDF. Transnational corporations invest in such networks because they find them cheaper and more reliable for data transmission between the parent company and the subsidiaries located in various countries. Corporations are linked through intra-corporate channels via closed user-group networks. TNCs use these to monitor and coordinate their affiliates to implement an integrated global strategy. Data flows are accessed by remote terminals linked to a mainframe computer at the corporate headquarters and cover such activities as production planning, standardization, financial control, research and development, employee relations, purchasing information, and legal reporting. These flows are essential for the performance efficiency and competitive costing of the operations of TNCs. So far corporations located only in the industrially advanced countries have been taking advantage of technological innovations in communications. The developing countries continue to supply raw data and purchase processed information and some telematics hardware. This is the same pattern in international trade in merchandise that has prevailed in the past, i.e., the supply of raw materials and primary products and the import of capital equipment. The information gap is now superimposed on an existing income gap between rich and poor nations.

The economic effects of TBDF controlled by TNCs is mainly on the international division of labor. It provides a system to which only financially powerful users have access which makes it feasible for TNCs to secure optimum advantage. Developing countries are unable to set up their own telematics and their bargaining position as host countries for TNCs is strictly limited by their meager access to TBDF. These same systems can be profitably set up and used by domestic corporations within host countries to foster self-reliant development. The operations of TNCs make it difficult in terms of costs for Third World countries to enforce national regulations which would widen participation in the advantages of TBDF. But the current position of data bases as reflected in Table 1 does not warrant optimism for access to an exponentially growing pool of knowledge. There

Table 1. REFERENCE DATA BASES
AND DATA-BASE RECORDS:
GEOGRAPHICAL DISTRIBUTION, 1975-1979
(Numbers)

Area	1975	1977	1979
United States of America			
Number of data bases	177	208	259
Number of records (millions)	46	58	94
Other developed market economies			
Number of data bases	124	154	269
Number of records (millions)	6	13	55
Total			
Number of data bases	301	362	528
Number of records (millions)	52	71	148

Source: Martha E. Williams, "Database and online statistics for 1979," ASIS Bulletin, 7 (December 1980), pp. 27-29.

are direct effects of the operations of TNCs in their control of the data market, upon the balance of payments of developing countries. It is a major cause of concern particularly to the non-oil producing LDCs. Total payment deficits for these countries have risen from \$53 billion in 1979 to \$70 billion in 1980 (CTC Report, Spring '82). Consequently their policies are directed not only to external adjustment measures, such as devaluation, but also to direct intervention with controls on specific items. While TNCs are not evenly distributed and do not have the same impact on all host countries, they do contribute to the effects of trade and service flows on the balance of payments of host countries. It is difficult to find published data on the exact quantum and value of data flows of TNCs but the direct effects lend

themselves to measurement more easily than the indirect effects. TNCs generally internalize opportunities by direct foreign investment and bypass international trade. This involves a trade-off between the price of goods and factors of production on the one hand, and the cost of information required for the process of international production on the other. TNCs reduce these costs of information through TBDF. For example, information regarding the exchange rates fixed and floating is monitored because these affect oscillations in commodity prices. Likewise input markets vary and their information is aligned with sales and distribution planning. In many ways TNCs can realize economies of scale by operating with international division of labor within the firm.

The ten largest data base distributors in the U.S.A. are (IDP Report, Vol.2, August 14, 1981, p. 3):

McGraw-Hill	Mead Data Central
OCLC Inc.	DIALOG Information Services, Inc.
Equifax Inc.	Bunker Ramo Corp.
Reuters	Dow Jones & Company
Dun & Bradstreet, Inc.	PRC Realty

These online data bases offer LDCs the quickest method of obtaining information of relevance to their needs, particularly business and scientific data. But demand for online information from LDC users is difficult to estimate and TNCs are not prepared to share such online sources of data supply with their potential domestic competitors in host countries.

As dependence for their operations on the international data market grows, TNCs are increasingly concerned about interference in corporate communications that could result from data protection laws (Cundiff and Reid 1979). Computer communications widen the sphere of control of TNCs but they also cause concern when countries thwart the establishment of global standards for computer network interface; and control rate structures for online access. A volume-sensitive rate structure could seriously impinge on the costs of TNC operations. Even within developed countries there is a growing apprehension of U.S. domination of the market for computer communications. This emerges from competing claims relating to the distribution of benefits engendered by the free flow of information between countries. It is analogous to the trade in commodities so that directions of TBDF reflect varying levels of economic development and technological capability. The theoretical conscript of comparative advantage in trade is set aside for data flows because of political issues of privacy and sovereignty. These issues are exacerbated by the unprecedented flows of information made possible by the innovative telecommunications technology, that render political boundaries innocuous and irrelevant. Developed countries such as

Sweden, West Germany, France, Norway, Denmark, and Austria have enacted privacy protection laws to control the transmission and storage of personal data outside their individual countries.

Control of the volume and value of TBDF by large corporations arises from the fact that the providers of processed data are located within the industrialized countries frequently interlocking their directorates with TNCs. In the U.S. alone Dordick (1980) estimates 30 major distributors of information services and products who offer their output internationally mostly in Canada, Europe, and Japan. They offer two general types of products and services: data banks and application programs. These services cover agriculture, airlines, banking, energy, education, engineering, demographics, economic forecasting, environment, prices, finance, government, and science and technology. Pricing of data available from such data banks is treated by TNCs like intermediate goods pricing that have a derived demand. These prices get reflected in the final pricing of information products. Application programs also supply processed information used by producers of final information products. The feasibility of access via terminals by TNCs gives them economies of scale and of specialization by reducing their costs of information gathering and factor use thereby altering the production function for their final output. Demand for data terminals in the U.S.A. is increasing at 20 percent per year with four million terminals in 1980.

4. POLICY OPTIONS FOR PRICING AND CONTROL OF TBDF

As TNCs increase their control over TBDF, countries involved in data flows use diverse means to make their preferred policies in this area effective. Urban centers in the advanced countries have become giant processors of information and therefore, users of communication technology. In the U.S. alone there are two million computer systems in use in 1981 and by 1984 that figure should rise to seven million. The total value of installed bases which is currently \$140 billion will, by 1984, reach a quarter of a trillion dollars (see Blumenthal 1981). Pricing of information processing is declining and hardware accounts for only 30 percent of total cost. This is the chief reason for the widespread use of computer networks internationally. However, like any other commodity such as steel or automobiles, data flows are subject to the rules of market equilibrium.

In 1980 approximately 46 percent of world trade was controlled by tariff and non-tariff barriers. The General Agreement on Tariffs and Trades (GATT) concedes that a large portion of traded goods is adversely affected by import restrictions introduced by industrialized nations. Now that such nations find their balance of payments critically influenced by the expansion of trade in services, for which GATT is not equipped, they are trying to resolve the issue as best they can. The wave of new protectionism which started with the oil crisis threatens to alter the world marketplace making it more vulnerable to shocks from economic policies

than it has ever been before. Such a trend for greater protectionism challenges TBDF in an interdependent world. It is up to the nations involved to realize and acknowledge that any extension of protectionism to TBDF would render the costs greater than the benefits. The networks are essential for developing countries to participate in the fruits of technology.

Economic justification for the control and pricing of TBDF is sought in the familiar arguments of national security, infant industry, balance of trade, and domestic unemployment. In this respect protection against TBDF is essentially an element of commercial policy. For example, Brazil has levied tariffs on foreign data processing services and imports of computer equipment in order to protect its domestic computer communication industry.

Another economic measure which protects the domestic data processing industry is price discrimination for the use of telecommunication circuits. Common carriers want to establish usage-sensitive and volume-sensitive tariffs on leased lines to replace the conventional flat-rate tariffs. The impact of such action will raise international communication costs thereby discouraging information access across national frontiers. The rationale for discriminatory pricing is the potential loss of revenues perceived by PTTs from reduction in the use of public networks. As TBDFs proliferate in use and volume, the concomitant increase in the number of value-added carriers is encroaching upon a market traditionally served by PTTs. After several years of sheltered control over public network services, the PTTs are confronted with organizational and economic problems in having to merge with entities that are privately owned and aggressively competitive.

In telecommunications hardware investment is related to the existing equipment structure of the total network. But in computer communications investments are kept flexible and adapted to meet the needs of future markets. Computer standards are set by private manufacturers rather than by international standards. The conflict between European PTTs and data communication corporations based in the U.S.A. is more marked, even though private networks exist in Europe, such as Nordic Net and TRANSPAC. The private systems have challenged the traditional monopoly of the PTTs and their investments in public data systems. This has led to a debate in the International Telecommunications Union (ITU) over proposals that private leased networks be integrated with public networks. Japan is charged with restricting trade opportunities by prohibiting transfer between data processing centers within the U.S. of data transmitted by leased line from Japan to the U.S. Likewise Germany limits U.S. exports of data processing services through regulations that require data entering Germany on internationally leased lines to undergo data processing within that country before distribution (Crawford '82). Not just American multinationals are seeking leased lines, but European, Japanese, and Canadian multinationals are also expanding their business information

systems which could operate more cost effectively with leased lines.

Against such a complex background the international debate on TBDF assumes a policy oriented significance. Governments want to retain their sovereign ability to access, process, store, use, and control information flows for the benefit of their economies. Concerns of data privacy, economic development, and the erosion of revenue of PTTs are fundamentally subsets of the above consideration. Increased government intervention in the pricing and control of TBDF is to be anticipated.

Government intervention has to operate with extreme caution in the market for TBDF. On the one hand in the U.S.A. Thurow (1982) is critical of management's failure to integrate technological change with international competitiveness. On the other, there are studies that point to the accelerated diffusion of technology by TNCs which help other countries to get a free ride on American innovations. This is considered the reason for shifting the comparative advantage away from the U.S. (Harry Johnson 1975). With government support it would be possible to speed up investment in R & D and make it internationally competitive. The U.S. has the comparative advantage in telematics hardware and software as well as in established and growing networks. This is the sector in which productivity is 40 percent higher than the national industrial average but to place restrictions on TBDF in order to preserve the comparative advantage will prove counter productive. Government intervention needs to be on the side of expanding the volume of TBDF and encouraging higher investment on the part of corporations in innovative research to maintain the competitive edge.

5. TRADE BARRIERS AND TBDF

Quite apart from taxing information as another commodity for raising revenues, trade barriers on TBDF are intimately related to the negative impact of data processing centers located in a foreign country on the balance of payments, and on domestic employment of a country that does not have an indigenous industry in data communications. Different countries resort to barriers on data flow in much the same way as they would restrict imports. For example, in Japan KDD contracts with American firms set limitations on data transferred, public network control of transmissions, and inspection of the American computer center and its software (see Blumenthal 1981). France would like to set a value on computer software for assessment of import duty and will use the GATT valuation code. The U.S.A. is urging GATT to lay out codes for regulation of trade in services. West Germany requires that all international leased lines must terminate in a single computer system and all data processing of international information must be done in West Germany before the data is distributed within the country. These regulations tend to increase installations that make the cost of transmission higher but less dependent on central units outside the country. Telecommunication companies in Europe and Japan are given preferential

support by their governments because the GATT Multilateral Trade Agreement excludes telecommunications from the Procurement Code. In this case data flows are likely to be broadly defined as telecommunications by interested parties who seek protection from international competition. Developing countries are becoming wary of what is termed as 'electronic imperialism' and countries like Brazil and Colombia want to restrict data flows and operations of remote-sensing satellites. Reciprocity agreements will have to be negotiated in the absence of GATT coverage. The PTTs in Europe are eager to control not only the type of information transmitted, but the conduits for transmission.

The TNCs are apprehensive of having their day-to-day routine operations affected by restrictions on global flows of information. Those TNCs which are in the data processing industry itself will have problems in marketing their products and in promoting R & D which is dispersed over several centers. These are regional support centers designed to monitor and diagnose any difficulties facing computer systems with consumers. The financial corporations will likewise experience problems in the transmission and control of worldwide transactions if there are barriers on such flows. Having operated under various forms of protection for merchandise trade, it now becomes difficult for First World countries to urge trade in information without similar barriers. In order to ease the operation of the market forces of supply and demand, industrialized countries will need to circumvent trade barriers by creating partnerships and joint ventures that do not neutralize the marketplace. Brazil has initiated a joint venture with Honeywell Bull to start the manufacture of computers in a company called Impressa Telematic.

Both Europeans and Americans want free flow of data but the Europeans want it through regulation and the Americans want to support a framework of rules to ensure free flows. The goal is the same, viz to prevent limitations on research and development in the application of innovative technology. It is in this context that Matthew Nimetz (1980) called for unified national policies to introduce "barriers against barriers." The new international regime may require voluntary agreements to minimize restrictive trends in an age of greater and more critical interdependence.

The major impact of regulations on data communications will be to freeze the expansion of corporate information systems. Investment in data communications is likely to stagnate both for primary producers of information products and services but also for secondary services like banks, financial institutions, automobile manufacturers, chemical companies, oil companies and other corporations that are information-intensive in their production processes. In the long run a shortfall in investment will adversely affect productivity and GNP increases.

If reciprocity in terms of restrictions against data flows begin to multiply, there looms the

danger of a global trade war in services. For instance, Brazil's monitoring of computer imports and data communications has forced U.S. banks and TNCs to invest in Brazilian manufactured computers and other equipment that is costlier and often in excess of their needs. In high technology areas the link between merchandise trade and trade in services is very strong and already services account for one-fourth of the value of total international trade. Furthermore, trade in "invisibles" is growing at 24.2 percent against a growth rate for commodities trade at 21.7 percent. However, trade negotiations take very long to sort out tariff problems as is witnessed by the two big rounds under GATT spread over 20 years to minimize tariffs, quotas, and non-tariff barriers against "visible" items. It is for this reason that the multilateral trade talks at GATT in November 1982 assume added importance. The major thrust of U.S. negotiators will be in the area of trade in services. Nations that believe they are competitively ahead want restrictions removed. But those that are behind want to protect existing industries or foster new ones. It is evident, however, that an international constituency for trade in services is growing.

The U.S. is endeavoring to raise the issue of services at the GATT where the world's major trade negotiations are discussed. Building consensus by laying the foundation for a sector by sector analysis of the services problem is the U.S. objective. But the GATT bureaucracy moves slowly and technology will not wait. Expansion of TBDF is growing exponentially. Although all countries with services will benefit from reduced trade barriers, the U.S. stands to gain the most because it has the highest exports in services than any other country. The Commerce Department officially estimated services exports in 1980 at \$45 billion; the real figure was \$128 billion (see Table 2).

Table 2. TRADE IN SERVICES

	1977	1980*
Receipts for exports	\$23,295	\$35,246
Travel	6,150	9,985
Passenger fares	1,366	2,582
Other transportation	7,264	11,041
Fees and royalties	4,713	6,993
Other private services	3,802	4,645
Income of foreign affiliates	\$69,220	\$92,964
Oil and gas field services	3,251	5,072
Petroleum tanker operations	8,249	8,991
Pipeline transmission, oil and gas	1,570	1,711
Finance (except banking), insurance and real estate	14,884	23,963
Banking	2,205	3,550
Construction	10,141	13,488
Wholesale and retail trade	2,950	4,868
Transportation and communications	13,412	14,619
Hotels and lodging	1,550	2,062
Advertising	1,448	1,926
Motion pictures and TV tape and film	1,063	1,414
Engineering, architecture and surveying	3,207	4,265
Accounting	433	577
Other personal and business services	4,857	6,458
Total	\$92,515	\$128,210

*preliminary

SOURCE: Commerce Department

6. THE FUTURE FOR TBDF

In the United States imports of information services are substantially less than exports but they are growing rapidly. Foreign data companies are exploring the American market which Crawford (1982) estimates at \$100 billion in 1990 as against \$25 billion in 1982. It is possible that if reciprocity is not forthcoming to protect TBDF from trade and non-tariff barriers like those described in the previous sections, then retaliation may be resorted to. In other words, restrictions by foreign governments may have to be answered by restrictions imposed by the U.S. government for denial of access to the U.S. data market. This is termed as "linkage" operations and may serve as a deterrent to barriers. However, it is difficult to establish access reciprocity in TBDF because of the intangible nature of measurement.

It has been shown in previous sections how computer networks of TNCs preclude national governments from taking effective decisions on employment, investment, and economic growth. This makes the

case for an international legal regime, such as the one proposed by the OECD, much stronger. The vulnerability of a computerized society in terms of employment is causing concern among OECD countries. It is difficult at this stage of negotiations to predict whether international approval of national controls over computer data flows will be similar to or different from the operations of the ITU for the use of radio waves and the orbital arc. The "Bing Report" on legal issues of TBDF (1981 OECD) has provided preliminary materials on the legal framework for regulating TBDF but the U.S. is critical of its contents, especially of the impact of the economic aspects of data flows.

It is certain that most industrialized countries have a vested interest in information technology trade. Income generation productivity and employment opportunities are all expanding in this sector. As opposed to conventional maturing industries, information technology is a dynamic sector which provides economies of scale and specialization. For the developing world it is a way for generating new production with export potential and a channel for increased foreign exchange earnings.

But these future possibilities are restricted by the fact that trade in information is different from trade in merchandise. What is traded is the content, the ideas, and the information. It may pertain to scientific data, finance, advertising, defense, or economics. It may cover proprietary discrete information. Content is more difficult to value and assess but it may also be politically sensitive like propaganda. The entire debate on news flows that emerged in Unesco centered on the content of media. So far as films, TV programs, books, and journals are concerned, the content is being valued and priced. But for data communications the value of the content is much harder to determine. Intra-corporate information systems find it difficult to evaluate an intangible product for which the market has yet to be defined. However, because the content is valuable, it is vulnerable to tariffs and other barriers. Market imperfections being greater in this area, the future of TBDF in economic terms warrants further scrutiny.

In sum, if we treat TBDF as a service whether delivered by a parent TNC company, or a bank, or a data network, it can be valued and exchanged in concrete terms. Economically speaking, it is subject to the same pricing and market forces as any other service for which there is derived demand. In the case of TBDF it becomes an intermediate service which links final demand for information with supply of computerized telecommunications. Such a theoretical and conceptual framework will make it much easier to grapple with the issues of trade barriers and non-tariff restrictions on TBDF. The fact remains that so long as the technology gap continues to exist between the First and Third Worlds, TBDF will continue to be similar to trade flows in that raw data will flow out from LDCs as processed data flows in. As this gap narrows and the markets shrink, the First World

countries will explore ways of keeping their technology edge to continue deriving the comparative advantage from international trade. The welfare implication of this process is that it is in the interest of all concerned to minimize trade barriers against TBDF either bilaterally or through GATT so that trade restrictions will not become counter-productive for both developed and developing nations.

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Elements of
International Communications Policy

Kenneth W. Leeson
National Telecommunications and Information Administration

Abstract

Dividing comprehensive policy on international communications requires that attention be given to at least six issues: a view of the international process underway in communications, scores of individual issues comprising the field, goals and objectives, political commitment, organizational structure in government, and strategies of diplomacy and negotiation.

A diverse range of topics arise in discussions of transborder data flow, including privacy protection, foreign direct investment, the activities of multinational corporations, valuation and taxation of information, employment and productivity, national sovereignty, and the principal of free flow of information to name just a few. In reality, the way information flows internationally and the effects such flows have on the economic and social interest of countries are the collective consequence of policies on science and technology, on trade, on communications equipment and computers, on international facilities and networks, and on service provided over those networks. Policy on transborder data flow is thus part of the broader issue of policy on international communications. This paper briefly reviews aspects of international communications policy and their interrelationships. (1)

Is it possible to derive from the vast field of activities that comprise "international communications" a systematic understanding of principal issues and of their significance for social, economic, and political interests? Will such an understanding provide sufficient guidance for the formulation of consistent and comprehensive policy?

The necessary, if not sufficient, components of consistent and comprehensive policy on international communications include:

- 1) A cogent view of the state of the world regarding communications and of the forces working to alter that state.
- 2) An identification of the individual issues that together comprise the whole of communications activities and, to the extent possible in an era of rapid technological change, an understanding of the relationships among them.
- 3) A hierarchy of objectives ranging from a global view of how the overall state of the world in communications should be encouraged to evolve to the desired conditions surrounding individual issues.
- 4) A measure of political commitment establishing a "pecking order" of priorities that will serve as the basis for mediating conflicts that arise from incompatible objectives.

- 5) An organizational structure of authority and responsibility for decision making to oversee the execution of this program.
- 6) Strategies of diplomacy and negotiation for the implementation of decisions taken.

A Cogent View

The first component outlined above calls for a "cogent view of the state of the world regarding communications." One rendition of such a view, formulated as a simplified abstraction is that:

- o Rapid technological change in high-speed computer processing and in communications speeds and capacities has created new opportunities for private enterprise and for individuals.
- o Enterprises and individuals vigorously exploit these opportunities and in so doing invoke changes in their behavior, activities, organizational structures, and the structure and competitiveness of the industries with which they are associated. They do so within individual countries and on an international scale.
- o Governments have come to recognize the growing strategic significance of communications and information for their economic, social, and political interests. With such considerations in mind, they do not always approve of the way enterprises and individuals, both foreign and domestic, exploit and adjust to the new technological opportunities. They may take various steps through laws or regulations to promote, discourage or otherwise control the adjustment.
- o These actions of government amend the "rules of the game" and affect the available opportunities. Enterprises and individuals adjust accordingly; additional technological opportunities present themselves; there is a reassessment by governments, and so the cycle repeats itself over and over.

It is this broadly-conceived process currently underway in the field of communications, that is, technological change, adjustment by private entities, reaction by government, readjustment, etc., from which the international "regime" under which information flows

among nations gradually evolves. It is this process and the accompanying evolution of the "regime" that constitutes the backdrop for every decision made regarding policy on international communications.

Identification of Individual Issues

Individual issues that comprise the evolving regime can be grouped into six major categories as follows:

I. State of the Art; Technological Knowledge and its Diffusion

This is the knowledge base from which the technologies and know-how required to build the communications and computer systems emanate. Three of the individual issues that fall under this heading are: (1) science policy and research and development activity, (2) indigenous national capacities, and (3) transferring technology on communications.

II. Physical Components; Communications and Information-Processing Equipment

The components of communication networks and information-processing systems play a significant part in determining the nature of the regime under which information flows. They are important in their own right, as well, because the production and sale of such equipment in both the home and foreign markets have important impacts on economic growth, employment, and trade. Individual issues that fall under this heading are: (1) domestic industry structure for producing hardware, (2) merchandise trade in computers and communications equipment and market access, and (3) technical standards.

III. Structure of Communications Facilities

Physical equipment is combined according to technological rules, negotiated technical standards, and institutional conventions to form the communications networks, the facilities up and running. Establishing the structure of these facilities raises the following issues: (1) domestic industry structure for providing communications services, (2) international facilities planning, (3) correspondent relationships, (4) international satellite system, (5) regional satellite systems, (6) allocation of spectrum, (7) allocation of satellite orbital slots, (8) vulnerability of systems, and (9) technical standards.

IV. Service Offered; Terms and Conditions of Use of Facilities

Though not clearly separable from issues concerning the structure of facilities, the issue of services offered and the terms and conditions of use of the facilities are a

somewhat different question. They concern, in general, the question of access rather than of capacity and touch more heavily on the interests of users rather than service providers. Twelve issues under this heading include: (1) trade in services, (2) rate structures, (3) liability for economic loss due to system failure, (4) use of public networks, (5) direct broadcast by satellite, (6) value-added services, (7) interconnection of equipment, (8) shared-use networks, (9) cryptography, (10) private leased lines, (11) resale of transmission capacity, and (12) integrated services digital network (ISDN).

V. Information Per Se

Issues here pertain to the treatment of information itself, as opposed to the facilities or to particular kinds of services. These include: (1) Press freedom and restrictions on journalists, (2) privacy protection — natural persons, (3) privacy protection — legal persons, (4) states as data subjects, (5) property rights on information, (6) valuation and taxation of information, (7) surveillance of content and, (8) remote sensing by satellite.

VI. Effects of Use or Application of Communications and Information Technologies

This category contains the principal areas affected by the use or application of communications and information technologies. Decisions made by governments on the issues listed under the first five categories above either affect or are motivated by the following considerations: (1) freedom of expression, (2) free flow of information, (3) national security, (4) balance of flows and developing countries, (5) societal adjustments to information technology in the home and workplace, (6) vulnerability of societies, (7) national sovereignty, (8) cultural diversity, (9) development of indigenous communications industry, (10) growth and development, (11) productivity and employment, (12) balance of trade and terms of trade, and (13) foreign direct investment.

Through a process of technological change and concomitant adjustment by private entities and governments, the issues listed above are the subject of the gradual evolution of the regime of international and domestic laws, rules, regulations, and practices that collectively establish the terms and conditions under which information flows among countries.

A Hierarchy of Objectives

The third component of consistent and comprehensive policy is a hierarchy of objectives. There are several problems involved in attempting to devise "global views" or general objectives. There is no clearly identifiable "national consensus" on international

communications in the sense of broad popular support for a particular global view and there has been no broad-based national discussion of the issue and no such consensus revealed. In addition to this lack of popular consensus is a lack of consensus on the part of the business community in the United States. To cite one example, users of communications services and providers of communications services may have quite different aspirations for the nature of the evolving regime and may support rather different global views. Even within each of these groups there can be found inharmonious aspirations.

There is also a degree of vacillation between wishing a meager government presence in dealings on international communications on the one hand and wishing a very effective and influential presence on the other. Where any given firm or industry association sits in this cycle often follows closely the emergence and resolution of specific problems that may abruptly upset the status quo and which require government assistance for rectification. When the problem ebbs, so may enthusiasm for government attention.

The absence of a broad popular consensus on objectives; incompatible interests among private groups that have significant stakes in how the international regime of communications develops in coming years; a lack of clearly articulated objectives provided by recent congressional activity; mercurial consternation regarding the implications for the balance between public and private roles of a more consistent and orderly government presence in policy and international communications; and the perennial revelation that any action taken in the name of communications stands a chance of being thwarted either by the pressure of competing national goals or through the absence of capitulation on the part of other countries—all of these together should provide ample discouragement for trying to identify global objectives. It has to be pointed out, however, that decisions on a wide array of factors that affect the issues in this "regime" are made every day, and although there may currently be no single "expressed" global view shared among the decision makers, each presumably is acting on the basis of some notion or conception (perhaps not explicitly stated, but generally shared) of the ultimate implications of the decisions. In addition, a factor that can provide guidance in formulating global objectives for international affairs is the domestic communications and information "regime" in the United States, perhaps the healthiest, most efficient, and innovative in the world, providing a large variety of reliable services under conditions of unimpeded flows of information. With a few caveats, the notion of adopting domestic objectives as international objectives is essentially a sound one.

There are attributes of the domestic "regime" under which information flows in the United States that would seem desirable to adopt as part of a global view for the international regime. Among these are strict prohibitions against restrictions on free expression and flows of information and a general preference for reliance on market forces whenever practicable to determine kinds of services provided, quality, and price. It is probably fair to say that these general attributes do

indeed constitute important bases for positions currently taken by the United States in international deliberations on issues in communications and in commercial and trade relations in general.

A policy that would seek to simply extend domestic attributes to the international regime would be, for obvious reasons, unrealistic. That is, other than through persuasion by example (or by entreaty), domestic attributes cannot be unilaterally hoisted upon other sovereign nations or blocs of nations, formal or informal, not of a disposition to embrace them of their own accord; but this does not prevent such attributes from serving a useful function in establishing the foundation for decisions made and positions taken on international issues.

In working toward devising a practical global view to assist policy makers in discharging their responsibilities, it is helpful to lay out some of the attributes that a broad view should possess. There are at least seven such attributes.

Since the breadth of responsibility is so wide,

- (1) the global objective should provide a basis for making consistent and compatible decisions over a broad range of related issues.

Since the evolution of the international regime of information flow is only one among a number of related issues of strategic importance such as foreign policy, defense, economic and social welfare,

- (2) the global objective should not compete in any significant or consistent way with other important national objectives or be so rigid as to preclude the possibility under certain conditions of capitulation in the face of conflict.

The evolution of the regime is a gradual process that will proceed indefinitely through time, hence,

- (3) the global objective should be sustainable through time and not subject to abrupt withdrawal or significant revision with changes in elected administrations.

The dividing line between international issues and domestic issues is thin at best in communications and, for many purposes, nonexistent. Decisions made in the domestic market will have impacts on the interests of other countries and decisions made by others will be felt in various ways in the domestic arena. In some instances, as is the case with international facilities, the decisions and their effects are taken jointly, thus,

- (4) the global objective should be consistent with objectives established for domestic activity and should permit accommodation whenever feasible of the objectives of other countries. (This does not, of course, preclude the taking of positions on individual issues that are in direct conflict with the objectives of other countries. Resolution of such conflicts should

be sought through negotiation and a process of give and get.)

As a state of general uncertainty with regard to the course of decision making is perhaps more debilitating of the actions of individual and commercial enterprise than is the consequence of any particular decision made,

- (5) the global objective should reveal a clear general direction for decision making that will help reduce the degree of uncertainty facing entities whose interests are directly affected by the evolution of the international regime.

As the policy makers will, in any event, be in the unenviable position of advocating decisions on issues that will have direct effects on interests from all sectors of the economy,

- (6) the global objective should be neutral or "blind" with regard to its effects on particular commercial interests (though it would be unreasonable to expect such neutrality with regard to individual decisions). Achieving such neutrality may require that the objective address itself not to specific outcomes for particular issues, but to the conditions under which activities take place and events unfold.

Finally, since policy makers must establish and support positions,

- (7) the global objective should be functionally useful, providing some basis for choosing among alternative courses of action and making decisions.

There are a number of formulations of overall objectives possible. Among them can be included the following:

- (1) Timely, accurate, accessible information whether distributed point-to-point or via mass media is the "final product" of the communications sector. Equipment and facilities, that is, computers, satellites, transponders, cables, microwave towers, networks, video display terminals and so on are valued ultimately for what they can do to facilitate some step in producing, processing, storing, transferring or disseminating information for use.
- (2) The terms and conditions under which information is produced and disseminated internationally — the amount and type available, its speed of movement, quality, accessibility and cost are determined by essentially three related factors:
 - (a) the state of the art — in equipment, facilities and information; the latest technologies and earlier vintages;
 - (b) the social and economic institutions and practices through which these

technologies are applied;

- (c) the laws and rules promulgated by governments on institutions and practices in order to regulate this application of state-of-the-art technology.
- (3) Relegating provisionally to a position of secondary concern all of the activities and interests that serve as intermediate inputs to the production and dissemination of information, that is, not having immediate concern for their interest or condition as factors separate from their role in accommodating the flow of information, then we are free to establish an overall objective for the policy maker. We could assign the policy maker with responsibility for overseeing the development of the terms and conditions under which information flows internationally, with a view toward promoting the widest variety of sources of information, the least expensive and most efficient means of processing and transferring the information, with the fewest possible impediments to its flow, . . . or some similar formulation.

Armed with the first and third observations as guidance on the overall objectives of policy in international communications and with the second on the basic international processes underway as a description of the methods available to pursue those objectives, the policy maker sets about reviewing all of the issues outlined earlier and their subparts, establishing or reaffirming positions on each and then planning strategies to carry out the responsibilities.

Commitment and Priorities

The potential for conflict with other interests in the pursuit of the objectives laid out in international communications raises the issue of political commitment and of establishing a "pecking order" of priorities that will serve as the basis for mediating conflicts that arise from incompatible objectives. This issue requires little elaboration.

Conflict will arise often, whenever the objectives for the regime of international information flow are incompatible with other objectives. As it is virtually certain that no objective in any area will have unchallenged precedence over all other considerations, it would not be possible in practice to establish a strict plan for resolving conflict in advance of an actual problem. It would be essential to the effectiveness of the performance of policy makers however, to have a generally unambiguous notion of the order of priorities. This must come largely from without, determined by deep-seated political philosophies, by prevailing interpretations of those philosophies, by mood or sentiments, and by the effectiveness of representatives of particular interests in influencing public opinion and the views of policy makers. The issue boils down to the level of "costs" society stands ready to impose on concerns and activities intermediate to or set apart from

the ultimate issue of international information flow, or alternatively, of the "costs" it stands ready to impose on international information flow when conflicting objectives seem of overriding importance.

Organizational Structure

Closely associated with the issue of political commitment to objectives regarding the substance of policy is the issue of commitment to the execution of policy and the need for an organizational structure of authority and responsibility for decision making to oversee the execution of policy.

On the question of carrying out policy, there are three issues that require attention: (1) the proper role of government in influencing the course of international communications, (2) design of the organizational structure and the placement of authority and responsibility, and (3) efficiency and comprehensiveness of the effort in relation to the amount of resources devoted to it.

There is currently no unambiguous guidance or mandate, either in law or in practice, that would satisfactorily settle the issue of the proper role of government in this area.

Is the development of the international regime of information flow an issue of foreign policy that necessitates a strong and organized government presence, to deal with what are largely the policies of other governments, in order to achieve desired objectives? Is it simply the international version of domestic policies on the treatment of information for which strict prohibitions are placed by the First Amendment on the power of government implying minimal or no concerted government involvement? Is it a commercial issue in which the traditional sanctions and prohibitions against direct government involvement in or interference with the domestic market place should be adopted as guidance for its role in the international arena? Is it similar to a trade issue in which the government has an active role as negotiator of agreements with other governments and as an intermediary in settling disputes? The problem is that all of these considerations apply to international communications, a circumstance that contributes in government both to organizational confusion in assigning responsibility and to a hesitancy to select decisively among paths that involve more or less government involvement.

A more effective government role need not imply a larger government role, either in the sense of intrusion into the domain of private enterprise or in the sense of cost. A view underlying this analysis is that government is already involved in efforts of some kind in most of the issues that have been raised here; the primary concern is with improving the effectiveness of the role it already has and not with expanding that role.

Whatever may be the conclusions drawn or agreement reached regarding the proper role of government, the question that next requires an answer is where in the Executive branch primary responsibility and

authority for international communications policy should be placed.

The issues involved touch heavily on foreign policy, defense policy, regulatory policy, economic policy, trade policy, employment policy, domestic communications and information policy, and financial policy. Currently there are cabinet level or other major departmental groups set up with primary responsibility for each. Where, then, does responsibility for international communications policy, in the comprehensive sense laid out here, belong? This is a question that remains to be answered.

Regardless of where primary responsibility is placed, effective policy formulation and execution will require the handling of a vast amount of information. There are half a dozen Executive departments concerned with some piece of this array of issues involving on modest approximation several dozen separate offices or other departmental subdivisions and hundreds of individuals; there are among them a variety of views about who has responsibility for what; there are now in existence any number of interagency committees and task forces meeting periodically on a broad range of these subjects to discharge their responsibility for some piece of the larger picture; various kinds of advisory committees meet to provide advice from private industry; there are delegations leaving Washington weekly bound for one international meeting or another to present United States "positions" on relevant issues; everyday there are major or minor shifts in the policies or positions on these issues of individual countries around the world; there are several international organizations each with an agenda and a more or less busy calendar of activities; Congress holds hearings on bills or proposes legislation that somehow contribute to the rules of the road in policy on international communications. How will policy makers effectively discharge the responsibilities assigned to them?

The solution lies in the application of the very technologies of communications and information that can be tagged as having raised the issues treated in this paper.

One of the principal determinants of the performance of the federal government in its efforts to develop comprehensive policy on international communications is the availability of information -- well organized, timely, accurate, detailed and easily accessible -- on the long list of issues and activities that comprise the area. Efforts to improve coordination will be frustrated unless all agencies involved can be kept informed about the substance of issues, developments throughout the world, the activities of other governments, positions and objectives established on individual issues, and the strategies designed to attain those objectives.

Thus, the question is how to remain informed on a vast array of issues and how to make sure that those throughout the government with involvement in some piece of the picture have the information they need to discharge their responsibilities, in harmony with the other activities transpiring and with the objectives laid

down. This can be accomplished by establishing a computerized information network. Its precise configuration need not be specified in detail at this point, but its salient characteristics can be.

A computerized data base would contain all of the necessary "files" of information. Among these files would be:

- Activities of the Executive branch, including:
 - o Diagrams or descriptions of where primary responsibility and authority rest for decision making on each of the component parts of the area.
 - o A list of interagency committees and task forces and their functions and responsibilities; a calendar of meetings and their agendas.
 - o A list of delegations bound for bilateral or multilateral meetings; a calendar of the meetings and their agendas.
- Profiles of the major issues of policy, along the lines of those listed earlier containing for each information on:
 - o Established United States positions
 - o Specific instructions for delegations scheduled to depart for meetings
 - o International forums where the issue is discussed
 - o Domestic policies on the issue
 - o Economic implications or interests surrounding the issue
 - o Political and social implications; implications for national security
 - o Positions assumed or actions taken by other countries
 - o Existing or imminent problems —specific cases
 - o Proposed recourse and strategies devised
 - o Coordinating body in the Executive branch
 - o Relevant legislation; congressional activity
 - o Calendar of activities; meetings with private sector, agency or interagency meetings, meetings of international organizations.
- Profiles of the communications and information policies of other countries containing, on a country-by-country basis, information on:
 - o General attitudes and directions
 - o Outlines of policy-making structures in government
 - o Characteristics of their domestic market — policies on competition
 - o Positions taken in international meetings
 - o Bilateral contacts with the United States; dates, issues, outcomes
 - o Enumeration of their laws, rules and regulations regarding communications and information.
- Profiles of international organizations containing information on:
 - o History and current status

- o Membership
- o Kinds of issues handled; agendas
- o International status or primary function; forum for discussion and exchange of views, promulgator of non-binding recommendations, of legally binding treaties
- o Calendar of upcoming activities
- o Executive branch agencies involved
- o Positions of the United States.

- Laws, in place and pending, that affect the issues and determine positions to be taken; calendar of congressional hearings.
- Current events, and late-breaking news obtained from the press and trade publications and from cable traffic from United States embassies around the world.
- Bulletin board, mail box facility for communications among individuals, for sending messages, making general announcements, clearing cables going to embassies or delegations, clearing Executive positions for congressional testimony.

The data base would be centrally located with each agency gaining direct, interactive access to it by on-line terminals located in its own office. Responsibility for upkeep of the data base — essentially adding new information and purging the obsolete — will rest with the agency assigned primary responsibility, though here there will be a procedure to enable each agency or user to submit information for inclusion on an ongoing basis.

Strategy

The sixth and final component of the program on international communications policy calls for "strategies of diplomacy and negotiation for the implementation of decisions taken." Specific statements or recommendations on strategy cannot very well be made until objectives are specified, political commitment declared, and the resources and organizational structure determined. Nevertheless, it is important to raise the kinds of questions that would have to be considered in devising a strategy. Among them are:

- o Is a "from-the-top-down" approach preferable to a "from-the-bottom-up" approach? That is, should global negotiations be undertaken among all countries with a view to specifying the general terms and conditions of international information flow, codifying them, and then having individual countries and private entities adjust their behavior accordingly; or should an atomistic approach be supported where the regime is left to develop piece-meal, with hundreds of decisions and agreements made among countries, bilaterally and in the appropriate international forums, on individual topics and according to the particular circumstances surrounding affected issues?
- o Is preemptive negotiation preferable to reactive negotiation?
- o Has the time come for negotiations on newly emerging issues of information flow? That is,

should discussions on emerging issues (those not now formally treated in currently functioning international forums for setting standards of various kinds) be sought now with an eye to setting standards, or would such a move be premature?

- o Should the general posture assumed and demonstrated in international discussions be active or passive?
- o Would it be more desirable to maintain the current institutional separations among major blocks of the whole field of international communications --telecommunications, trade, the mass media, computers --and act on them separately, or are these separations becoming obsolete and meaningless or even misleading?

Answers to these questions will have to be sought in light of several considerations. For example, one of the objectives of international discussion and negotiation is to promote a climate in which individual nations can effectively participate. The extent to which any given country is prepared or suited to participate in international activities will depend in no small way on the degree to which the international regime replicates its domestic regime. It is not surprising to expect,

therefore, that in negotiations countries will attempt to infuse their own familiar habits, conventions, and practices into the international sphere. The greater the national differences in economic conventions (e.g., rules of private enterprise), legal structures (e.g., common law, statute law), and social traditions, the more difficult is likely to be the effort at striking compromise.

In future discussions and negotiations on other aspects of the evolving regime the problem of differing domestic legal, economic, and social traditions will have to be dealt with time and again. The outcomes of negotiations may be a move toward "harmonization" of laws where countries try to adjust their domestic practices to international requirements, "accommodation" where different national approaches are maintained and tolerated, by treaty where supranational rules are devised, or, a third possibility, no satisfactory resolution and discord.

- (1) Excerpted from "International Communications: Blueprint for Policy," Kenneth W. Leeson. Forthcoming. (East-West Communications Institute, Honolulu, Hawaii).

COMPUTERIZATION AND THE TRANSFORMATION OF SOCIETY

Herbert S. Dordick
Annenberg School of Communications
University of Southern California
Los Angeles, California
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We define computerization as the widespread use of the semi-conductor microchip to provide intelligence, control, sensing and other functions for manufacturing and in products.

The ongoing debate about the computerization of society can be summarized in the following opposing arguments:

- * The development of microelectronics is merely another step in the normal direction of technological change and will have the same effect on society as the long stream of inventions that have characterized the ongoing industrial revolution.
- * "...the modern era of electronics has ushered in a second industrial revolution...its impact on society could be greater than that of the original industrial revolution."⁽¹⁾

Microelectronics, the chip, computerization have already penetrated into the economies of developing countries. Airlines and banks wishing to operate internationally have installed computers to link world-wide and one frequently finds their clients installing computer terminals, thereby forming networks of new elites, communication or information elites, in the developing nations. Industrial parks, modeled after Silicon Valley in California and Route 128 in Massachusetts have sprung up in Thailand, Malaysia, and Indonesia playing host to U.S., Japanese, and South Korean firms performing highly sophisticated and automated manufacture of chips or assembly of equipments with microelectronics for export.

While it appears that computerization will have significant impact on life in these nations, other technological developments in the past have also resulted in tremendous changes. Air travel, nuclear energy, satellite television and communication and the chemical processes that have so significantly affected agriculture, the Green Revolution, have all had very heavy impacts on life.

The question is whether "the difference between these developments and microelectronics is merely a qualitative one or of a different order of magnitude,"⁽²⁾ or both.

Whether or not there is a second industrial revolution taking place is a question not solely of academic interest. Nations make plans based upon expectations and if there are expectations that such a revolution is taking place and that they can benefit from that revolution, national plans will be made to prepare for it. Unfulfilled expectations backed by investments to support these expectations can be disastrous to these nations.

Identifying the Industrial Revolution

Economic historians are still debating the dimensions of the Industrial Revolution. While there are, as can be expected, numerous points of disagreement as to just what parameters can best describe the consequences of this important watershed in history, it is useful to deal with several about which there is somewhat less disagreement. The changes resulting from that industrial revolution can be stated as follows:⁽³⁾

- * Population growth occurred at an unprecedented rate. Demographers estimated that in 1750 world population was about 800 million. In 1980 it was in excess of 4 billion.
- * In the West, agriculture ceased to be the dominant activity. Industry and service sectors accounted for more jobs. And as a consequence, the Western world became an urban society.
- * Technological change had become the norm, and was expected to be continuous. New energy sources were harnessed and new materials and substances were constantly being created to satisfy the demand for new products. An increasing flow of new inventions, discoveries, and new production methods resulted in relatively high levels of industrial productivity in the industrialized nations and, where adopted, in many of the developing nations.

With these measures alone one could argue, with considerable success, that we are merely in a continuing stage of the industrial revolution begun in the 18th century and that no significant societal transformation is taking place today. World population continues to grow essentially unabated. In industrializing nations such as Taiwan, South Korea, Brazil, Argentina, Singapore and even India, attempts are being made to reduce dependency on the agricultural sector by increasing productivity through scientific farming and mechanization and to increase the development of the industry and service sectors. Indeed, development is often measured by the relative sizes of these sectors in competition with the agricultural sector with higher points being given to the industry and service sectors. And who can deny that rapid technological change continues to be the norm?

Yet we are aware of a change that is occurring in society, beginning in the developed world and, inevitably, in the developing world. Clearly, there are other factors that we must look to in order to determine if a transformation is taking place, factors that, perhaps, were not in evidence during the emergence of the industrial revolution in the mid-eighteenth century.

Looking for Transformations Today: The Availability and the Nature of Work

The application possibilities for microelectronics are many and varied; they extend across all aspects of society and affect all sectors of the economy. Applications of chips range from consumer goods; electronic watches and calculators, home appliances to personal communications and computers, from improving the efficiency of motors and internal combustion engines to providing automated means for traffic control, from the automated farm with the ability to manage and schedule operations more efficiently to the automated factory with robots that sense their environment and adjust to change, from the automated office to the automated bank and retail store for transacting personal services more efficiently. The results can be rapid increases in productivity. Because productivity tends to increase faster than economic growth, unemployment across all sectors of society can result.

What makes these developments certain is continuing drop in prices of the microelectronic components that are designed into the systems and hardware for use on the farm, in the home, office and factory. Rapid diffusion can be expected. Furthermore, the applications of these devices will not be limited to mass production operations. The microelectronic chip packaged into intelligent microprocessors will offer the ability for products to be designed to meet varied market demands, to satisfy consumer tastes that change rapidly across time, products that are custom-tailored. Microelectronic devices offer high degrees of flexibility for product design and process control.

It is in the factory and offices where the chip promises to have the most profound impact on employment. Not only will robots in the factory and intelligent word processors in the office increase productivity, but the manufacturing and information processes in factory and office, respectively, will be significantly altered.

Evidence of a transformation is slowly accumulating from firms in the more advanced nations where the great preponderance of chips are being used for the assembly of end products. Information processing and telecommunications industries in Great Britain, Sweden, and the United States report work force reductions ranging from 20% to almost 40% over ten year periods while there were substantial increases in the volume of production.⁽⁴⁾ India has reported substantial savings in office labor as a result of the increased use of computers and other office equipment in both public and private enterprises.⁽⁵⁾

Robots and other automated devices in the factories and in the banks, retail stores, insurance companies, and warehouses appear to be improving productivity through the substitution of human labor by intelligent machine labor. In the past, productivity was achieved primarily through growth in production volume over time; in the future, productivity may very well be determined by the amount of capital that is invested per unit of product.

Small computers accessing data libraries, multi-mode communication systems capable of voice, video and data communications and word processors are sharply altering

the nature of managerial work and information functions and patterns in the office. For the first time in many years there is some evidence that office productivity is increasing and the number of information workers in public and private enterprises are levelling off and in some cases decreasing.

The evidence seems to indicate that only among product salesmen and product engineers and designers, skilled maintenance and repairpersons for automated production lines and management will there be rising employment opportunities in electronics. For the assembly line workers both in the developed as well as developing nations, for equipment and system assembly as well as wafer or chip assembly, there will be falling employment. The emerging information society, the supposed consequences of computerization, carries with it the concept of information work and information workers. It was Porat⁽⁶⁾ who initially sought to define information occupations and his attempts have been theoretically valuable for defining an information sector. However, what information work is, is still undefined.

Schement and Lievrouw⁽⁷⁾ have attempted to define two major classes of information work and further identify five categories within these two groups. These are:

Intellectual manipulations:

- Information producers
- Information recyclers
- Information maintenance.

Material manipulation:

- Information technology producers
- Information technology mainainers.

Neither Porat nor Schement and Lievrouw are successful, it seems to me, in identifying a transformation as measured by the nature of work. If there is a transformation of society, it will manifest itself in entirely new and altered job categories and these cannot be determined by examining information drawn from the data developed from the occupational categories in the ongoing industrial revolution. One cannot define new change with data from old assumptions. All one does is manipulate old data into new bottles when, in reality, the very contents of the bottles are changing.

New definitions are required--definitions of jobs that are drawn from the workbenches in the factories today. And these can only be obtained by monitoring what is taking place on these benches over time.

The Privatization of Information

There is increasing concern among many that the information economy will lead to limitations on access to information and that the pervasive computer-communications networks will be used to privatize information rather than to socialize information. Those that can afford to purchase information will be given access to the networks while those who cannot afford the cost will be denied access. Political elites will reinforce their positions by denying access to information to all but their own.

The ability for creative people to capture a larger share of the benefits created by their work has been and continues to be a major factor in increasing the rate of technological progress. Some argue that it was the ability for inventors to see personal gain from their inventions that was significantly responsible for the industrial revolution. This belief has been captured through social legislation that awards patents, copyrights and protection for trade secrets.

There are those who argue that these are the very factors that create the growing gap between the information haves and the have nots. Yet, the highly valued inventions of the computerized society will be information products, software programs, firmware chips, production processes, specialized market information, financial information, timely shipping data, creative works of art, music, dance and drama that can be transmitted world-wide and protected for proper payment. The need for the protection of intellectual property will be as important, if not more so, in the future as it has been in the past. Indeed, the ubiquitous computer-communication networks, which will become increasingly transparent as microprocessors become more intelligent through the clever design of new and better semi-conductor chips, will make the task of protection increasingly difficult. Privatization will be expensive but necessary in order to maintain the rewards for intellectual property, indeed, the need for such protection must be met in order to encourage the invention of information products for the computerized society. How to do so may very well be one of the more difficult tasks confronting countries seeking to computerize.

How does one choose between the case for efficiency, for providing incentives to inventors to invent and the case for equity, of making knowledge freely and universally available so that all can benefit? During the past 200 years, we have had no difficulty making that choice; the efficiency argument won and continues to win in the courts but with increasing difficulty.

An excellent argument can be made that in a computerized society with numerous communicating and computing networks providing a thick mosaic of connecting paths, with international linkages equally plentiful and with intelligent personal microprocessors composed of even smaller and less expensive microchips, it will be virtually impossible to control access to information, to privatize information.

Is it this inability to control free access to one's intellectual capital in an era when that is all the valuable capital there is that indicates a new era, a societal transformation. Given the current trends in the computer and communications technology, it is a fact that there may not be a gap between the information poor and rich. To the contrary, there is a likelihood that access could be free and universal. Certainly we can make it so through the use of the information technologies. To do so would, indeed, require a transformation of society's economic works, indeed a major transformation.

Redefining Work, Employment, and Unemployment

It is, understandably, difficult to discuss notions of work and leisure, of occupations and unemployment, in the context of the developing world today. The heavy impact

of the microelectronic revolution will occur several decades from now, perhaps in two or at the most, three decades. There are and will continue to be disputes whether or not the emerging era will see fewer jobs, how many, what kinds, and where, or if new jobs will be created to take their place, how many, what kinds, and where. One thing certain, however, is that the trend is towards an era of vastly different kinds of jobs. They will likely require less physical labor, fewer hours and may even disappear. The chip and its consequences will alter the role of work in human life. These alterations may begin to appear in the developed nations within the next ten or so years and within the developing nations, perhaps in the next generation.

The computerized society will not eliminate work as a human activity but could radically alter it. In general, work is defined as some human activity that results in a specific effect or output, produces a good or service that satisfies a need. Work is an activity that is related to a physical or mental activity that is purposeful and that purpose is understood and appreciated by the recipient as well as the worker. Furthermore, the worker is rewarded for that activity we call work.

There will still be the need for human activity in the computerized era, but it will be less time consuming, less physical, perhaps not as clearly related to some defined output and it will very likely be "less emotionally rewarding" for the worker. For in many societies "hard work is good for you" and man is rewarded in some proportion to the amount of sweat on his or her brow.

The future will still see fewer people "working" fewer hours. Means will need to be found to allow workers to be and to feel rewarded for less work. A notion which might be called "creative unemployment" needs to be defined and developed. Any activity that provides some internal reward for the practitioner of that activity should be considered as a form of creative unemployment. Perhaps it is continuing education, perhaps it is practicing family and religious rituals, perhaps it is some form of self-expression. In any case, it will be important for society to re-define employment and seek ways for workers to be and feel rewarded, at the same time.

The argument or point about work and the nature of work is not made merely to indicate that there is a shift from agriculture and manufacturing to service work. This shift does not indicate a societal transformation but merely the de-skilling of labor that began in the early 18th Century with the demise of the craftsman and which is continuing as workers shift to jobs requiring what one might call natural human skills rather than learned intellectual and mechanical skills.

The point is that in the computerized society the service jobs will also be automated and will disappear. In the long run, there may be less need for "work" as it is now defined. The very fact that we seek a new definition of work and of unemployment is an indication that a transformation may be occurring.

We have not resolved the questions raised in the beginning. But we have identified three areas of inquiry which must be explored to determine if a transformation is occurring that will sharply delineate the industrial revolution from an Information Revolution. These are:

The availability and nature of work,
The privatization of information, and
The need to redefine work, employment and
unemployment.

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HOW APPROPRIATE IS APPROPRIATE INFORMATION TECHNOLOGY?

Oswald H. Ganley
Program for Information Resources Policy
Harvard University

The U.S. government is once more becoming alert to development problems. It is willing to incorporate modern communications and information (C&I) technologies into assistance programs. In light of this questions regarding the suitability and adaptation of technology, cultural and social change, and who will pay are discussed.

The prolonged downswing from the enthusiastic Post World War II development efforts in the U.S. seems to have bottomed out. This downswing began in the late 'Sixties and reached an all time low with Schumacher's Small is Beautiful(1) and the "appropriate technology" drive of Congressman Clarence Long in the mid 'Seventies. Now winds are beginning to blow out of Washington which indicate that an upturn in opportunities could be occurring.

There has been a recent recognition of the importance of new communications and information technologies for all areas of political, economic, social and security endeavors. This includes those which could be devoted to development. And, as a part of its overall emphasis on a deeper involvement and responsibility for the private sector, the present Administration appears willing to unleash high technology for development efforts. This is good news for those persons in both advanced and less advanced nations who want to see these efforts move into the information age.

Perhaps one of the strongest indicators of a move toward policy change was contained in Current Policy,(2) where former Under Secretary of State James L. Buckley described basic U.S. Government policy objectives in the communications area.

In this article, Mr. Buckley said of the communications and information area that:

"We stand at the dawn of a new era of human history, the full implications of which we cannot yet begin to fathom. Yet, under the compelling imperatives of exploding technologies in the communications and computer fields, we will have to work now to develop coherent national policies capable of embracing a growing diversity of increasingly complex enterprises."

And he gave seven major policy objectives, including the following:

"To enlarge the communications and information capabilities of developing countries. (Emphasis added).

"National economic development, regional political stability, and a healthy global economy require

effective communications and information capabilities. Developing countries can gain significant economic and social advantages for their internal development, as well as a more effective voice in the responsible conduct of world affairs, through improved communications. Enhancement of commercial and broader economic relationships depends upon effective communications and information exchange relations. Existing U.S. development policies stressing basic human needs must recognize to a greater extent the need for improving communications and information capabilities of developing countries. Greater involvement of the U.S. private sector is also needed."

Mr. Buckley's article is amplified in a draft U.S. policy background paper, "International Aspects of Communications and Information." (*) (3) Some of the points made in the background paper are:

1. That adequate communications and information capabilities are an integral part of the infrastructure of developing countries in the same way as are ports, improved waterways, electric grids, all weather roads, and aviation.
2. That developing countries must determine their own priorities, but that it is evident that in many such countries, the priorities assigned to communications and information are too low.
3. That the developing countries themselves, as well as international and regional funding institutions and donor nations including the U.S., must pay increased attention to assessing and meeting developing country communications and information needs.
4. That, within the amounts presently available for developing country assistance, a greater share ought to be assigned to communications and information needs.
5. That:
"If the present legislation emphasizing 'basic human needs' limits the scope of efforts related to communications and information, consideration will be given to seeking revision of such legislation."

The background paper says that where countries are ineligible for bilateral assistance, then reimbursable technical assistance will continue to be stressed and a review made of the effectiveness of the present arrangement. There is an item, too, that, within current budgets for multilateral institution assistance, the feasibility of a stronger technical assistance program within the ITU will be considered.

Another hopeful indicator out of Washington is some congressional testimony on the uses of microcomputers in development. Curtis Farrar, Deputy Assistant Administrator for research of AID, (4) cited six sectors with 35 categories where microcomputers are serving or could serve as useful tools for development purposes.

The above are all indicators that an atmosphere is beginning to develop in the U.S. in which some broadly conceived experimentation with communications and information in development could take place. I would emphasize the words indicators and beginning. But these indicators do represent the strongest signals we have had in a long time from the U.S. Government on this subject. And they are more than we have yet had from the World Bank, for instance, or from other aid-giving countries. How rigorously such a trend will develop or how long it will last is anybody's guess.

Whatever these indicators mean, we can be sure of one thing: They will not solve any of the basic problems of which development is heir. They won't take care of who will benefit, or of the possibility of increased dependency, or of how to deal with labor displacements, or of which technology to use, or of who will pay. They will not solve the problems associated with social change. Quite the contrary since all of the above general problems of development may prove especially bothersome in the area of communications and information.

I believe that the rhetoric concerning "appropriate technology" may now be behind us. My own approach to appropriate technology goes something like this:

A technology is appropriate if it can take root in a new environment and lead to economic and social growth. It is appropriate if it is useful in solving the needs of the country or the industry in which it is involved. Whenever possible the adaptation or indigenous modification to suit local conditions of "outside" technology is to be encouraged. And care must be taken to modulate resulting changes in the social fabric in such a way that the pace and depth fit the capacity of the recipient country to deal with them.

The developed nations of the West are getting a good lesson right now in adaptation from their fellow developed country, Japan. The genius of the Japanese experience has been that they did not

simply copy Western technology, allegations to the contrary notwithstanding. The Japanese have adapted the technology developed by others to their own needs and circumstances. And I have to add that they have done this at great cost to themselves. In adaptation as in everything, there is no free lunch. If you buy a cheap solution, you get a cheap result. This is nowhere better demonstrated than in the introduction, unchanged, of U.S. television programming into other countries.

Ideally, developing countries will eventually go on to create their own technologies which are specifically geared to their own needs. This is unfortunately a step that generally takes place fairly far down the development road. But it is an ultimate end toward which development efforts should be aimed.

I know that there are many people in both developed and developing countries who hold different views of what constitutes suitable technology. My worst fear is that paralyzing squabbling will again set in which could prevent seizing this new opportunity and moving forward. There is usually some room for mid course correction if necessary.

When we talk about development there is simply no way we can paper over the problem of cultural change. There is no use pretending it won't occur. Even if we did nothing it would occur in some way. Cultures are and always have been dynamic, constantly shifting, processes in all countries and among all peoples of the world. But technology certainly accelerates the process. The United States experience of moving its people off the farms and into the cities has resulted in enormous cultural change. In 1860, the U.S. farming population represented 80 percent of the country's total population. Thirty percent of the U.S. population was still on the farm in 1940. This has now dropped to less than three percent. The same thing has happened in every developed country in the world. It is a part of the process of development. It is a part, especially, of the applications of communications, transportation, and other more sophisticated equipment in any country, not just in developing ones.

The real question is not will changes occur but rather what form will the changes take? Cultural change can ruin some of the existing good. It can also eliminate some of the existing bad. Those who fear cultural change believe there is a special danger that we may lose the present diversity of our cultures and that the whole world will become one big homogenized mass. So the real question is, what sets of values will partially or wholly replace the existing ones as these changes take place. Will cultures become primarily Western or Soviet? Or will they remain regional or indigenous? What will the rate of this change be? Will the people involved

have time to adapt? And how can the shock best be absorbed?

In a recent New York Times article, Libya's minister of culture is quoted as saying:(5)

"We sit here, watching the television, using the telephone, and thinking we are part of the Twentieth century...but we do not even know how to use this...You go to Saudi Arabia and you see a man with a Sixteenth century mind driving a Twentieth century car and thinking he is modern...but the car is more modern than he is.

This need not necessarily be a contradiction. I am sure that Henry VIII or Elizabeth I would have been thrilled to have a Cadillac equipped with a telephone. They would never have turned it away from their door. In that case, England would be a different England today, of course. But not necessarily an inferior England.

Many cultural arguments against the introduction of technology are valid arguments. But I am not without suspicion of some of them. I am not an expert on culture. But I do consider myself something of an expert on international politics. I certainly understand that subjects of legitimate controversy can become footballs in the wider context of the world's economic and political struggles. The happenings at the recent UNESCO meeting of ministers of culture are good examples. This is a prime area, I think, for getting oneself bogged down.

The developing countries are not the only ones facing change or fearing it. The advanced countries are in the midst of a major cultural revolution as their economies become information-intensive. Will they be able to cope? Will they be able to provide the education the young will need and the re-education of the adult worker? Will they be able to deal with the unemployed due to the redundancy of outdated crafts? They hope so. They have adjusted in the past and they think they can deal with this new situation. They even hope that this time they can perhaps deal with it a little less painfully.

Transfer of developed country technologies to the developing world is not an unmixed blessing for the originating countries either. New economic competitors, new military forces, and more potent, possibly adverse political entities are bound to emerge.

It is my belief that we must all cope. The advanced countries are going to get more and more competition, even if it is just among themselves. The West has got to deal with the East. And the developing countries don't really want to be left behind again. Several developing countries are taking no chances and are moving impressively ahead in the communications and information area. Singapore, Malaysia, South Korea and Taiwan are some examples. Jussawalla(6) estimates that

already by 1973, 24 percent of Singapore's Gross Domestic Product could be attributed to the information sector. And it may be much more now.

But we should not just have to cope. Let's look at the opportunities. For the first time in history we have communications and information technologies which can help us leapfrog some formerly intractable problems. These seem to me the most appropriate technologies of all. For instance:

... We now have communications satellites which can bind distant parts of countries or regions together. And they are already doing this in the form of INTELSAT and regional satellite systems.

... We have meteorological satellites that can warn of storms and be of immense aid to the farmer.

... We have remote sensing satellites that can provide information on natural resources, earthquake faults, plant diseases, and so on.

... We have fiberoptics that can be used to build overland communications networks more cheaply than was possible with older technologies.

... And we might as well go directly to the new digital telephone switching systems.

AID's congressional testimony(7) spent fifteen pages on the virtues of the microcomputer in the service of development. Television can certainly be useful for education, including birth control, and agriculture and for health and maternity care. And, in the developing as in the developed world, the telephone can be the workhorse for business, emergency, and a myriad of other uses.

Having dwelt on the opportunities, I will return to a prime problem. Who is going to pay for all this?

Joseph Pelton estimates(8) the cost in trillions of dollars but so far not even the millions are available. Through December 1977, the Inter-American Development Bank had loaned \$196.8 million for telecommunications projects, or only 1.6 percent of its total loans to that date.(9) This means that it ranked next to last of all the sectors it financed, the one toward which the world now seems to be heading. Meanwhile, the World Bank is still waiting for definitive economic proof that communications and information indeed contributes to the development process. Nor does the new warming trend in Washington significantly extend itself to money. Financing for the communications and information area is truly dismal. Thus, a combination of developing country government aid acting as a catalyst, together with private enterprise and a host country environment favorable to private investment, will be crucial.

To summarize, the U.S. government is once more becoming alert to development problems. It is willing to incorporate communications and information into the game. This is a healthy step forward but it is not yet an occasion for joyful celebration. And it may not last. Those persons who are interested in bringing communications and information to bear in development now have an opportunity. But it must be seized. Paralyzing squabbling is one of the greatest enemies of any future communications and information development attempts. The problems are still enormous but the possibilities have never been greater. We should take Washington up on this opportunity. And we should do it now.

NOTES

1. E.F. Schumacher, Small is Beautiful. New York: Harper & Row, 1973.

2. James L. Buckley, "International Communications and Information Objectives," Current Policy No. 377, March 7, 1982.

3. U.S. Department of State, Office of the Under Secretary, "International Aspects of Communications and Information," Unpublished, February 12, 1982. While the background paper has no official standing, it has been submitted by the U.S. Department of State to several key congressional committees. The ultimate aim is to help develop a consensus on policy and the paper is a part of the process.

4. Curtis Farrar, Statement of the Agency for International Development before the Subcommittee on Investigations and Oversight and the Subcommittee on Science, Research and Technology of the Committee on Science and Technology. U.S. House, July 15, 1982.

5. Alan Cowell, "Amid H1-F1's and AK-47's, a Libyan Identity Crisis," The New York Times, Sept. 14, 1982, p. A2.

6. Meheroo Jussawalla and Chee-Wah Cheah, "Towards an Information Economy: The Case of Singapore," Honolulu: East-West Communication Institute, East-West Center, July 1982.

7. Curtis Farrar, supra note 4.

8. Joseph Pelton, Global Talk. Alphen aan den Rijn, The Netherlands: Sijthoff and Noordhoff, 1981, p. 210.

9. Heather E. Hudson, "The Role of Telecommunications in Development: A Synthesis of Current Research," presented at the Tenth Annual Telecommunications Policy Research Conference, Annapolis, April 25-28, 1982.

Information Technology Transfer: The Philippines

Florangel Rosario-Braid with Emma J. Fabian
Executive Dean and Project Officer
Asian Institute of Journalism
Manila, Philippines

The present pattern of information transfer in the country is still primarily linear and diffusionist although there is recognition of the need for interactive models. Some attributes for a development and participatory model are suggested. DOMSAT Philippines as a communication technology provides opportunities for application in development through its potential for two-way communication.

Recent models of technology transfer focus on the notion of participation and mobilization as necessary processes. However, many of the countries in the developing regions do not have the necessary social, cultural, and economic structures to speed up the evolution towards a participatory society. Many of them are authoritarian societies where power resides in government and oligarchies and where the transfer of technology and information has been a top-down process. The imposition of external models such as modernization have served only to reinforce the old structures as these linear models require that the flow of information or knowledge should come from a central source. The diffusionist approach has therefore been the predominant model in the planning and implementation of communication technology.

Like in many Third World countries, communication resources in the Philippines are concentrated in the urban areas. There is a lack of "trickle-down" of information from the cities to the rural areas which are largely "information deprived" communities. While attempts are being made to link the rural areas with the center through decentralization of government and other vital services including information media, these efforts have been inadequate. The flow of information from information centers to outlying areas has been hampered by several factors.

A major constraint in development planning and information transfer in the Philippines is that it is highly centralized. The planning environment may be described as "government-oriented... (and) often associated with the domination of a technocratic elite that focuses on "social" efficiency and "public" rationality at the cost of democratic participation".¹ Policies and program directions are conceptualized by highly educated technocrats heading the various ministries of the government.

There is also a tendency to regard information as a source of power. Because those who have access to information and information channels assume more powerful positions, they tend to withhold information to prevent a wider dispersal of power. In a country where media ownership is controlled by a few oligarchs with close connec-

tions in the government, information is often controlled in order to protect vested interests.²

Another limitation affecting the transfer of information technology is the fact that communication hardware development often precedes the development of software. For example, broadcast stations are set up even before program philosophy and strategies are developed. As a majority of mass media enterprises are commercial in nature and primarily entertainment oriented, the problem of software planning is not of great concern. But there have been a number of experiments in the use of community technology for education and development (educational radio and TV, specialized periodicals and audiovisuals, distance learning, etc.) which have followed the pattern of "hardware before software" development.

Cost-effectiveness measures built into experiments in communication hardware development are insufficient; considerable outlays have not been commensurate to productivity increases. For instance, the "blue revolution" to increase fishing yield has resulted in increased productivity but investments in fishing gear have been rather heavy. Even if there is now a move from capital intensive fishing technology, newly-established small-scale fishing enterprises are beleaguered by lack of information on labor costs, capital investments, and supplies. Moreover, self-reliance and endogenous development are slowed down by the propensity of planners to invest in high-cost imported communication technology. The dependence on multinational firms for technology as well as servicing and replacement parts often cause unnecessary delays in construction and repair, and involves great cost outlays in the long run. Since it never follows that costliness is either desirable or necessary, elitist gatekeepers should be oriented towards the long term advantages of low-cost and indigenous technology. They are better adaptable to local needs and conditions; they foster creativity and initiative in the utilization of local resources; and they encourage the growth of self-reliance.³

Social, psychological and cultural factors also tend to be neglected in technology planning. In the case of domestic satellite, the construction of an earth station near a subdivision in Southern Philippines encountered considerable resistance from residents who believed that the station could be a source of microwave pollution. Their fears were actually unfounded but much delay and controversy could have been avoided had the planners involved the people in a dialogue about possible consequences of operating a satellite station before embarking on a full-scale construction.

The big media enterprises cover much of the archipelago but their effectiveness as channels for information technology is limited by the lack of feedback and interactive mechanisms through which the people can "talk back" to them. The opinions and needs of the masses are usually expressed in letters to the editor and occasional feedback to broadcast stations. Moreover, mass media provide inadequate coverage of technological breakthroughs because of a lack of translation skills and a partiality towards reporting "events" rather than "processes." This orientation has provided a limited view of science and technology developments which should be seen as the result of processes and interactions with various sectors of the population. And since most media enterprises are based in the cities, information packaging is urban-biased and have little relevance to the needs of the widely dispersed communities outside the cities.⁴

The efficient dissemination of information technology is further hampered by the existence of bureaucratic bottlenecks and poor coordination of implementing agencies. It appears that the facility of implementing a project varies in inverse proportion to the number of implementing institutions that need to coordinate with each other in the undertaking. For example, in the implementation of Masagana 99, poor coordination among the implementing agencies has resulted in conflicts over control of resources, delays in scheduling, and other organizational problems.⁵

Inadequate mechanisms for replicating and multiplying technology have also limited information technology transfer. Many innovations launched as pilot projects have had very little impact in terms of reach. For instance, research on the use of extension media such as radio and newspaper have shown that the utilization of information from these channels were usually limited to people living in more accessible places, i.e., in the more urban barrios.⁶ Inhibiting factors like the cost of transportation hamper the distribution of newspapers in far-flung areas. As a result, although a considerable amount of information on new techniques is being generated by research institutions, there is very little "trickle-down" to potential users.

It has also been noted that there exists a high drop-out rate in the adoption of innovation due to inadequate institutionalization. This may be

traced to the lack of involvement of beneficiaries of change in needs identification and program implementation. It may also be due to the lack of follow-up mechanisms to ensure the continuous utilization of the innovation.

As a result of the aforementioned constraints in the transfer of information technology, information flow has been essentially a linear, top-down process. Innovators diffuse new knowledge through mass media and opinion leaders to reach the target audience and the role of communication is to make the audience aware of the innovation and to motivate them to adopt it. However, this process has been found wanting since studies have shown that increasing the quantity of messages on the innovation does not necessarily ensure its acceptance. Furthermore, the emphasis appears to be heavily biased towards the product with little attention on the process.

A pattern of information flow in agriculture indicates that the transfer of information is from a formal source (extension agent, radio, printed materials) to the farmer or through informal channels (neighbor, friend, etc.) For example, it was shown that the most important initial sources of information for farmers are: extension workers/field or home management technicians; peers; and neighbors/friends/relatives. It was also found that individuals rather than mass media were the main sources of information. Mass media were generally resorted to when the primary sources were unavailable or if they did not have the information. The farmers selected extension agents as their primary source of information and the influential factor for the adoption of new knowledge because they were perceived to be more knowledgeable and possessing more authority. This was further facilitated by the frequency of contact with the source and their availability for consultation.⁷ A study by Pestilos and Escalada reinforces these findings and Castillo (1977) calls the extension worker the "conduit" for agricultural technology. Similar observations on opinion leaders as sources of information were reported by Manigque (1978), Dy (1979), and Gomez (1978) in Orozco (1981).

The above findings support the diffusion or one-way approach which is found to be pervasive in the flow of information in agriculture. This pattern may also be observed in the flow of information in family planning, nutrition, and health.

Another pattern shows that message production is centralized, that is, they emanate from government agencies, advertising agencies as in the case of Masagana 99, or trained scriptwriters of extension institutions. There is little involvement of recipients in message formulation as it is assumed that planners have adequate knowledge of their audience without need for consultation.

The patterns of information flow in the Philippines should be viewed in the context of existing dyadic

structures in Philippine society.⁸ These structures involve vertical interaction between superior (superordinate) or authority figures and subordinates whose communication exchanges are characterized by:

- focus on non-verbal behavior, euphemisms, and indirect discourse instead of frontal verbal encounters and arguments;
- emphasis on the maintenance of smooth interpersonal relationships;
- emphasis on information networks in the flow of communication;
- emphasis on authority;
- emphasis on assistance to economic sufficiency and security rather than achievement and responsibility.

In vertical relationships, authority figures constitute the primary sources and channels of information. Any interaction between superordinate and subordinate is goal-oriented; power sharing or information transfer is exchanged for loyalty or some other social or economic reward. The primary purpose of communication often becomes the need to further one's socio-economic status.

This communication structure reinforces that of an autocratic society where information and power trickle down from the top and is highly dependent on the source's predisposition to share it. The system inhibits the flow of information to the masses because it encourages the hoarding of information as the latter supports the maintenance of power. Information transfer is therefore primarily diffusionist and centralized. Development strategies designed to initiate structural changes should focus on the need for more democratic sharing of power and information.

Towards a Prescriptive Model

The basic criteria in the selection of communication technology must be derived from development goals. In view of the move towards decentralizing development planning and decision-making, technology which provides greater feedback mechanisms would give greater access and participation to the people.⁹

A model linking endogenous development and self-reliance with the evaluation of communication technology has been proposed during the International Institute for Educational Planning (IIEP) Seminar in 1980.¹⁰ It was based on the recognition of the limited applications in technology adaptation of mass media owing to their homogenous approach which tended to support the diffusionist, top-down flow of information.

The model is concerned with how the acting system arrives at decisions concerning the creation and adoption of communication technology, and implements these decisions; and to what degree the acting system is perceived to be self-reliant. Through the analysis of a number of cases in which communication technology have

been transferred in order to attain specific development goals, a set of guidelines and criteria was formulated to assist in solving problems in information technology transfer and adaptation.

The IIEP model may be related to what Tehranian describes as "open planning" or participatory planning. As contrasted with centralized planning, open planning is "the process of decision-making on the rational and democratic allocation of a society's limited resources to reach certain objectives by establishing targets and plans designed through active consultation, participation, and interaction of key actors in the planning process".¹¹ Crucial to the role of communication are the concepts of rational planning and popular participation. For while all systems are vulnerable to demands for access and participation, they choose to accede to it in different degrees and times. Tehranian has identified seven critical stages at which popular participation may occur in the planning process, namely:

- Assessment of needs and expectations
- Assessment of resources and constraints
- Formulation of goals, strategies and policies
- Programming and budgeting
- Implementation
- Research and Evaluation
- Revision

The role of communication in open planning is to expand, integrate and mobilize. In expansion, communication seeks to build up its resources in order to strengthen the communication system. In integration, it reconciles apparently conflicting interests and goals of the different sections of society through participation, dialogue and consensus; and in mobilization, communication resources are pooled for the operationalization of the goals of development.

The very importance of participation of the beneficiaries of change and receiver institutions in the planning, packaging and distribution of technology is emphasized in a new model.¹² It suggests that "the development of local capability and skills is perhaps the most important technology in the transfer process."¹³ Counteracting the neglect of the process in technology transfer, the new model provides a needs and methods analysis whereby information on needs and methods is collected and examined through interactive systems provided at every step of the process of technology transfer. A mechanism is provided to feed the people's reactions and needs back to the planners thus involving the people in the planning process. The user-oriented communication

system would then:

- ° link client systems with resource institutions;
- ° link research institutions with resource institutions so that feedback on client needs may generate changes in innovation or strategies;
- ° link institutions charged with institutionalization of the technology with appropriate government agencies;
- ° check the adequacy of messages (accuracy, relevance, comprehensibility);
- ° monitor program performance and modify content of messages, strategies and technologies;
- ° convey market signals to those allocating technical resources;
- ° ensure partnership between client and resource institutions;
- ° encourage local initiative over external technology;
- ° emphasize building of local capability shown in administrative and technical skills.

Domestic Satellite Philippines, Inc. (DOMSAT)

A promising vehicle for development information technology transfer is DOMSAT which was set up in 1976. While the system was envisioned "to promote simultaneous nationwide distribution of television and radio programs for information, education, and entertainment," it still has to operationalize these objectives particularly in the area of development support. Although it has 165 channels available, only 100 has so far been utilized. In television, only one network Radio Philippine Network - RPN (a commercial station) is using the facilities. The government television channel avails of its facilities for occasional two-way video exchange for special government programs. It can only lease its circuits to authorized carriers such as the Philippine Long Distance Telephone Company, and not to direct users.

It can be said that its application is primarily supportive of business and urban-centered concerns and that although its coverage for the commercial channel reaches the entire country, certain factors limit its usefulness as a development conduit. They are:

- (1) most of the programs of RPN have little relevance to the needs of rural communities. It has few public

affairs programs and even these are oriented to urban viewers.

- (2) its capability for two-way interaction is limited only to occasional video exchange coverages of special events such as when the president of the Philippines talks to the people on national concerns.
- (3) utilization costs are still high. Its subsidized rate of P4,000 (US \$455) per hour at night and P3,400 during the day for government broadcasts makes its use by development agencies still prohibitive.

The capacity of the DOMSAT network which leases 1½ transponders from the Indonesian Palapa-2 satellite to serve its 11 earth stations is as follows:

1 TV relay channel for Manila-outbound service to 10 fixed earth stations and one transportable earth terminal;

1 transportable TV transmit service for occasional use and limited number of receiving points;

1 program relay channel (radio) for Manila-outbound service to 10 fixed earth stations;

165 single-channel per carrier (SCPC) voice grade channels capable of handling 82 simultaneous telephone conversations.

Each of its earth stations can be utilized for intra and inter-regional communication in the territory. The people behind DOMSAT are however unable to take the initiative in leasing their facilities to development agencies unless the latter are able to pay its subsidized rates. To date, it has also built two networks of communication for the Ministry of Education in order that the latter can establish educational and training projects in two regions. A large financial outlay was required to get these networks established. However no other agency utilizes them so that economies of scale are not achieved.

It appears that the problem of lack of use may be traced to:

- (a) lack of an explicit national policy which would stipulate application of technology for development programs;
- (b) lack of understanding of the potential of satellite communication for supporting development;
- (c) lack of skilled manpower particularly in software development and design of the learning and utilization system.

Following is a summary of the advantages of DOMSAT for information technology transfer, particularly focussing on its capacity for two-way communication:

- (1) it allows simultaneous coordination of activities in dispersed areas;
- (2) it allows greater interaction among regions through its two-way capability;
- (3) helps create a better atmosphere for work in regional offices because of reduced isolation;
- (4) maximizes the use of local/widely dispersed expertise for simultaneous consultation and interaction;
- (5) saves travel costs considering the opportunity cost of time; productivity is increased by saving on travel time;
- (6) facilitates speedy and efficient dissemination and exchange of information through the combined use of expertise and dialogue;
- (7) provides alternative message channels. This is especially advantageous when calamities cause communication black-out due to the breakdown of the more conventional communication channels. For instance, it provided the alternative communication channel during the breakdown of the local telephone and telegraph services during recent typhoons.

Many of the integrated area development projects (IAD) in the country are located in areas where DOMSAT has installed earth stations such as the Cagayan Valley, Bicol region, Leyte-Samar region and Palawan. The IAD program has recognized the importance of strengthening its development communication program particularly in coordinating the various infrastructures and social services, and in reaching the beneficiaries of the programs. DOMSAT can demonstrate that an improved communication system which is able to bring planners of programs in regular interaction, thus reducing travel to and from various points in the region might be a more efficient and effective alternative. Economists should be able to measure this "trade-off" between transportation and communication in terms of both social and economic benefits. But before any further expansion towards the application of satellite technology is made, the following prerequisites are essential, namely (a) explicit policies; (b) administrative mechanisms to implement policies with representatives from government, business, academic, and labor sectors; (c) guidelines for software development and public participation should be developed.

A review of communication technology transfer in the Philippines would show the following pattern:

- (1) Technology planning and generation is from the center with little participation from the users.
- (2) Communication hardware planning and implementation often precedes that of software.
- (3) Cost-effectiveness measures are inadequate; capital investments are considerable that impact in terms of productivity may not be commensurate to the costs of initial inputs.
- (4) Dependence of communication technology on multinationals who supply technology as well as replacement parts and maintenance has threatened the growth of self-reliance.
- (5) Social, psychological and cultural factors are often ignored during the introduction of technology.
- (6) Technology often have limited feedback and interactive mechanisms.
- (7) There are inadequate mechanisms for replicating and multiplying technology; many of them remain pilot projects with little impact in terms of reach.
- (8) Delays in the implementation of technology are caused by bureaucratic bottlenecks and poor coordination among planning and implementation agencies.
- (9) There is a high drop-out rate in the adoption of innovation due to inadequate institutionalization and local capability in management.

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AUSTRALIAN COMMUNICATIONS POLICY

Tony Keulemans

Abstract.

Telecommunications and broadcasting policy in Australia has been largely of an ad hoc nature. The introduction of a domestic satellite system and new services such as cable TV, force reappraisal of existing policies. The reports of two recent national inquiries will, if adopted, have significant implications for policy formulation, especially those recommendations which advocate network competition. A comprehensive communications policy document, which takes full account of social, economic and technological imperatives, is overdue.

INTRODUCTION

Telecommunications and broadcasting policy in Australia has its origins in the Wireless and Telegraphy Act of 1905, the Broadcasting and Television Act of 1942 and the Telecommunications Act of 1975. The pragmatic nature of policy decisions in recent years reflects not only the influence of industry pressure groups but also that of the media, activist groups and individual politicians and academics. The influence of some of these disparate groups could at times be regarded as disproportionate compared with that of the government departments directly concerned with the preparation of policy advice. Changes to policy are now imminent as a result of the forthcoming introduction of Australia's communication satellite and the possible development of cable television (CTV) and radiated subscription television (RSTV).

Most domestic telecommunication signals (telephone, facsimile, telex, data services etc. and networked radio and television) are currently carried by Telecom's terrestrial co-axial and microwave broadband system which serves all but a very small proportion of the population living in remote areas for whom a normal telephone, radio and television service is not yet practicable. The marginal cost of additions to the network to cater for these smaller communities in the outback is very high. This need plus the opportunity to improve national radio and television networking, are claimed to be the major factors in the decision to introduce a domestic satellite system in 1985. The satellite would of course meet other domestic telecommunication needs including defence and civil aviation as well as serving as a back-up to the terrestrially-based network.

The main bodies associated with the management or control of communication services were, in November 1982, as follows:

Department of Communications. The present federal Minister for Communications is The Hon. N.A. Brown, Q.C., M.P.

Australian Telecommunications Commission. (Telecom Australia). A statutory body responsible for the provision, maintenance and technical standards of all terrestrial common carrier and related services.

Overseas Telecommunications Commission (OTC), the statutory body responsible for transmission/reception of overseas telecommunications (via ocean cable, terrestrially-based and satellite systems, e.g. Seacom, radio-telephone, Intelsat etc.).

Australian Broadcasting Tribunal (ABT), the licensing and regulatory body for radio and television operators. (The national broadcasting service follows principles established by the Tribunal but being accountable only to federal parliament, is outside ABT jurisdiction).

Aussat Pty. Ltd., a limited company established to manage the operations of the domestic satellite. Approximately half of the shares are likely to be owned by the government.

Significant broadcasting users of the network are:

Australian Broadcasting Commission (ABC). The national broadcasting service has one television and two AM stations in each of the State capitals, Canberra and Newcastle. There are 76 regional TV transmitters and 77 regional radio stations; 29 of the latter have local programming capability. FM broadcasting: 15 FM transmitters serve all major capital cities and eight provincial centres. The ABC also provides a shortwave radio service to outback areas and is responsible for the external service, Radio Australia. In addition to TV translators fed off air, the ABC leases capacity on Intelsat IV to provide television programmes to outlying areas.

Commercial AM and FM radio and television.

National bodies : Federation of Australian Commercial Television Stations (FACTS) and Federation of Australian Radio Broadcasters (FARB). Three commercial TV channels are available in Sydney, Melbourne, Brisbane and Adelaide, two in Perth and one in Canberra, Hobart and major regional centres. A number of radio stations are located in each capital

and at least one AM station is to be found in country centres.

Special Broadcasting Service ("ethnic" radio, "multicultural" television). SBS television programming is networked regularly from Sydney to Melbourne.

The ABC is the major user of the network for the relay of radio and television programming but the network is of course used regularly by many public and private organisations for other telecommunication requirements besides that of the telephone.

Telecom 2000, a publication prepared by the National Telecommunications Policy Branch in 1975, was regarded as a guide to possible directions in Australia's social, economic and technical future to the year 2000. It recognised the general trend towards digital telecommunication networks and envisaged a range of new services to take account of existing and emerging technologies, e.g. wide-band cable (or optical fibre) systems. It acknowledged that social requirements would need to be adequately identified and evaluated. Public responses to Telecom 2000 were contained in Outcomes from the Telecom 2000 Report (1978); further opportunities for debate were provided by the seminar on "Social Research and Telecommunications Planning" organised by the NTP Branch of Telecom in 1979. Comments on the published Proceedings of that seminar were also sought from the public.

Discussion has also been initiated through seminars and symposia organised by educational institutions and various private and public organisations on aspects of the old and new media, some with futuristic themes on the impact of communication and information technologies. The findings of the Committee of Inquiry into Technological Change in Australia (1980) are also relevant. In all, a considerable amount of socio-economic and technological data has accumulated over the last few years.

RECENT DEVELOPMENTS

In September, 1980, following advice from the Satellite Project Office, the then Minister for Posts and Telecommunications, Mr Anthony Staley, announced in the House that the Government had decided that a request for tender would be issued for the supply of a domestic communication satellite system. The specifications for the tender were evaluated by COSMAT and the European Space Agency. The tender was subsequently awarded to Hughes and a launch by the Space Shuttle has been booked for 1985. Mr Staley stated that a particularly important aspect of the decision was the Government's commitments to providing a dependable telephone and a national radio and TV service to the remoter areas of Australia via small and relatively inexpensive earth stations based on houses or homesteads. Single residences and small aboriginal, mining and station communities would thus share in the service at a

very modest cost.

The space segment will consist of three satellites, two in geo-stationary orbit (one in operation, one as standby) and a spare on the ground. Four of the satellite's fifteen transponders will be used to provide a focused coverage over four separate areas of the Australian continent with a power approximately double that of an Australia-wide transponder. The four spot beams will be able to carry radio and TV signals; in the case of the HACBSS (Homestead and Community Broadcasting Satellite Service) the greater power to each footprint will make reception possible by small earth stations (approximately 1½ meters diameter for homesteads and approximately 5 meters for those earth stations located at the sites of regional transmitters). The national beam serving the Australian mainland, Tasmania and certain off-shore territories, would use larger, more powerful earth stations for reception and transmission of interstate signals.

These new capabilities will considerably enhance the ABC's national service enabling programming injections to be made from a large number of points throughout Australia. The commercial radio and television operators are also likely to be significant users of the satellite system for networking purposes.

The system design makes provision for any requirement by the government of Papua/New Guinea for thin route rural telephone services and possible later distribution of a national television service. Mr Staley added:

A similar requirement for a number of south-west Pacific nations has been carefully considered, but regrettably could not be included in the proposed first generation satellite system without significantly increasing costs and substantially impairing the performance of the planned satellite system. This has particular reference to Western Australia.

Recognising the important role that satellite systems can play in the provision of national and international telecommunications for the South Pacific region, however, and mindful of the importance of Australia's relationship with the region, the Government has taken a decision, in principle, that planning for the further development of the Australian system should take into account services for the South Pacific countries provided either in later Australian satellites or in a regional system shared with Australia.

The Australian Government has already indicated to the South Pacific countries its readiness to participate as soon as possible in detailed discussions to identify their telecommunications needs and how these might be best met through INTELSAT and/or cooperation with Australia.⁽¹⁾

Discussions have since taken place at the South Pacific Telecommunications Conference; it is understood that the specific needs of the South Pacific area will be given serious consideration in the planning of the second-generation system.

Of more immediate policy significance is the publication of the 5 volume Report of the Australian Broadcasting Tribunal on cable TV and radiated subscription television services and the 3 volume Report of the Committee of Inquiry on telecommunication services in Australia. The latter Inquiry, chaired by Mr J.A. Davidson, Chairman of CIG, was tabled in Parliament on 28 October, 1982, only a few weeks after the Report of the ABT was released. At the time of writing (early November) both reports were still being evaluated by the government and other interested parties.

The ABT has recommended a mixture of private and public ownership of cable TV giving Telecom and the business sector equal opportunities to construct, maintain and operate the system. Licensees of CTV Systems would be expected to make available a designated amount of channel capacity for lease by public or private bodies. A licensee would also be required to provide a separate channel for community access, children's programming, educational purposes and to provide capacity for upstream communications. More generally, the ABT expects CTV to be used for the provision of "enhanced" data and video services.

In the case of radiated subscription TV services, it expects private industry to provide the service recommending that the ABC and SBS be excluded from this activity. The use of UHF channels is advocated for subscription television but VHF and SHF are not ruled out in special situations.

Some limitations on the ownership and control of CTV and RSTV are urged based on factors such as prescribed interest levels, total media interests and the viability of existing broadcasting services. The same general principles concerning foreign ownership of commercial radio and television broadcasting would apply, except that less onerous restrictions would apply in the early stages.

The report recommends that both services be introduced as soon as practicable but that subscription TV come first. Significantly, the ABT acknowledges that a Communications Act is required that covers all aspects of broadcasting and telecommunications.

Pending a full study of the report, the Minister has merely commented that "these recommendations have significant implications for the broadcasting, entertainment and information industries."

It is perhaps of interest that under the terms of reference of the Davidson Inquiry, the Committee was to determine how private industry could be given (not whether they should be given) a wider role in the provision of telecommunications services. The "Australian Financial Review" in its headline of October 29, captured the main theme of the Report: a "Blueprint for Telecom's reduced role... a win for business..."

The Davidson committee in effect recommends an end to Telecom's traditional monopoly in the provision of network services and advocates the restructuring of the Commission to a taxpaying incorporated company, 100% government owned but operating under minimal government controls. The report envisages full scope for private enterprise to compete in providing long-distance and other telecommunication services, either through independent networks or through re-sale of Telecom leased lines. In either case, private sector network operators would have the right to connect with Telecom's existing national network subject to meeting independently-established technical standards. Independent networks authorised by the Minister would not be restricted in the class of traffic carried; "common carrier" obligations could be imposed on some operators if non-discriminatory public access to independent networks was considered desirable.

Other recommendations refer to the reassessment of Telecom's pricing policies to minimise price discrimination and to adopt timed local calls. Greater competition in terminal equipment would be permitted and preference buying from local manufacturing industry would cease. The report also envisages that Aussat Pty. Ltd. would emerge as a major competitor to Telecom in long-distance telecommunication services. It asserts, however, that Aussat should not be allowed to own its own terrestrial networks (in case this activity is subsidized from its monopoly on space operations), but should be permitted to interconnect with the Telecom network, buy capacity from a Telecom lessee, or buy capacity from an independently licensed network operator.

The Davidson Report may conflict with some aspects of the ABT report in asserting that aerial reticulation of CTV systems should not be permitted. It also considers that Telecom should own and maintain all cable and equipment in Telecom ducts. Cable infrastructure should, it states, be clearly separated from provision of cable services. The Report also recommends that the Minister for Communications be responsible for issuing licences to competitive carriers but without the usual public inquiry process.

The "Financial Review" comments that the Committee eschewed the American model of services regulated in a competitive environment, regarding regulation of the system i.e. "carriage" rather than content, as more important. The Committee emphasizes its concern to simplify procedures and includes a draft Telecommunications Act, recommending that enactment of new legislation have first priority.

The Minister is quoted (Nov. 1, 1982) : "In my view we have a report which provides an excellent charter for the development of telecommunications in Australia in the future." He has invited community reaction to the Report within the next 3 months.

Opposition to certain sections of both Reports may be expected from Telecom's unions and from rural interests who could be disadvantaged by the proposed abolition of Telecom's uniform pricing policies. Lobbying is also likely from some of the larger electronic companies supplying Telecom who stand to lose from the abolition of preferential trading rules. Other groups such as "Cable Action" are concerned about the recommended exclusion of the ABC from any major ownership or operational role in the new media (the ABC being faced already with stiff competition from the commercial radio and TV stations) and what some groups regard as inadequate guidelines concerning cross-ownership, foreign ownership, children's programming, Australian content and educational and access channels.

POLICY IMPLICATIONS

The potential of increased channel capacity from CTV and satellite systems for various audio, video and information services, new possibilities for interconnection and networking and the proposed involvement of the private sector, have opened up a range of policy issues for determination.

A major issue is the implied challenge to the economies of scale argument for "natural monopolies." Because it is assumed that alternative carriers are likely to concentrate on specialized services, the Davidson Report apparently considers that Telecom's multi-

billion dollar investment in its infrastructure will not be seriously affected. With increased flexibility to compete itself in a range of services, Telecom may be able to maintain the viability of its overall operations. Telecom would be concerned however, about the opportunities provided to commercial competitors to "skim the cream" of its more lucrative services. It would be argued that any program of action that emphasises entrepreneurial profit opportunities should be evaluated against the benefits of a natural monopoly to the public interest, before any new policy is set in concrete.

As the recommendations in both Reports are largely consistent with the government's free enterprise, market-oriented philosophy, however, acceptance of the main thrusts seems likely. With an election imminent, some media reform groups are concerned that enacting legislation will be rushed through without adequate debate. A Labour government is likely to favour regulation and a centralised, co-ordinated system of development so that the *status quo* is more likely to be maintained, in the short-run at least, if that party assumes office before any new legislation is enacted.

Although three year mandates may inhibit long-term planning and the development of a comprehensive communications policy, the attempt needs to be made, in preference to a piecemeal or "band-aid" approach to specific technological developments or isolated problems. There should be no shortage of Australian socio-economic and technical data for the drafting of a broadly-based communications policy document. In recent years a number of government committees have examined such topics as FM broadcasting, educational broadcasting, multi-cultural broadcasting, the national broadcasting service, technological change and telecommunications generally, which together with the most recent inquiries, have yielded large amounts of information. Useful material of relevance to the formulation of policy also exists in other countries, including the Pacific Basin countries, from which lessons may be learned. From inquiries with a narrow focus, the time has surely come for a broadbrush approach by government, one which integrates the relevant findings and take account of the service potential of new technologies and their contribution to national development.

The economic and technological interdependence between telecommunications and information processing is such that any distinction between these systems, between carriers of audio/video signals and data signals, is rapidly becoming blurred. Their convergence has also been associated with declining costs, as in the case of computer hardware and satellite capacity. The trend towards the further development of digital networks will no doubt provide

opportunities for further efficiencies and operational economies in the terrestrial system. Meanwhile print materials and transportation costs have been increasing. Some services should thus become more attractive : teleconferencing, electronic mail, facsimile, computer assisted instruction and other forms of on-line access. Although new technological developments are not necessarily "prime movers" in changing social attitudes or behaviour, as the price of hardware and software (in both real and money terms) continues to fall, greater utilization seems inevitable. The communication and information industries are already dominant contributors to the Gross National Product.

In education, the instructional potential of communication and computer technologies extends to pedagogical improvements such as individualized interactive learning. Moreover, these modes of transmission are not constrained by the delays associated with manually-based distribution systems. In the context of an information society, or one with restraints on the allocation of energy resources, one may speculate that the socio-economic costs of traditional education, (capital costs of buildings, daily costs of travel, social costs of traffic congestion, pollution, travelling time, accident rates etc.) may be debated more vigorously. On-line and other interactive video services in education can provide a diversity of self-paced instructional material, can help overcome space and time constraints and reduce consumption of energy and other resources.

There are of course legitimate concerns about any removal of the human element in education or displacement caused to the teaching profession. Not all teachers would wish to become software specialists or to adopt the role of counsellor/facilitator at some remote terminal. However, if the mature student feels that he or she can learn some subjects as effectively from computer terminals and in less time, some resistance to the perpetuation of traditional teaching/learning practices may be expected. If more teacher/student time is saved, there should be more opportunities for human interaction.

Clearly in the development of communications policy, one eye should be cast towards the social and economic costs and benefits arising from the substitution of communication and information technology for many fields of human endeavour. Education is only one of many social activities that may be affected positively or negatively by the new communication/information order. Other issues such as access, "free-flow" of information, the proprietary nature of information and the right to privacy will also claim the attention of government. The range of human concerns would need to be appraised in the

context of the various components making up the total communication system, as part of the planning for a socially acceptable national communications policy.

Ideally, the drafters of new legislation would do their work with long-term national objectives in view and without considerations of political expediency.

(1)

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Canada's DBS Woes: Culture or Profit

Thomas L. McPhail
The University of Calgary
Calgary, Alberta, Canada

Abstract

Canada's newest and the world's first commercial DBS system, Anik-C, is being tilted to service U.S. mainland customers. This will result in considerable economic gains for Canada's Telesat-TCTS. But one of the major reasons for Canada's extensive government involvement in funding Anik was to provide satellite communication services to the North and remote areas. The tilting of Anik-C away from the Canadian North to more adequately serve U.S. customers, awaiting a U.S. DBS system in the mid 1980's, has raised several policy-related questions. The paper examines the conflict between the commercial and economic objectives of Telesat-TCTS and the cultural and social objectives of the Canadian government and taxpayers subsidizing the Canadian satellite programme.

INTRODUCTION

In November, 1982 the first commercial direct-to-home broadcast satellite (DBS) was launched from the U.S. space shuttle Columbia. Somewhat ironically the satellite was not American(1); it was Canadian. Even the Japanese did not develop the first high-tech satellite system that Canadian manufacturers and designers have constructed.

Yet this same DBS satellite, known as Anik-C with the more powerful 16/14 gigahertz band, has spread fear among Canadian communication policy makers and Canadian broadcasters alike. To further extend the irony, the first commercial customers utilizing Anik-C are in the United States.

The Canadian broadcasting industry is worried because DBS offers a potential range of communication services that will undermine their fragile advertising base, plus by-pass local stations. The policy makers are worried because DBS will carry even more foreign software, including foreign norms, values, and perspectives into Canadian living-rooms. DBS is viewed by many as an "electronic Trojan horse"(2).

Canada has an excellent track record at developing satellite hardware; it has an abysmal record in developing appropriate Canadian software. Commencing in 1976 with the first experimental DBS in the world to the current Anik-C, Canadian engineers, supported extensively by Canadian government funds, have allowed Canada to be on the cutting edge of communication technologies. But a parallel concern with the software and cultural impact has been almost nonexistent. What makes the Anik-C an ambivalent

system is that it is being tilted to the U.S. to serve U.S. customers first before Canadian customers(3).

The Canadian satellite services present a classic and clear case of competing and incompatible objectives: the one objective being economic viability; the other being cultural determinism. What follows is a description of the current Canadian situation where the tilting of the satellite Anik-C to service mainland U.S. customers is becoming controversial. It is easy to visualize in the near future the tilting of Canadian satellites to service Pacific Rim countries and customers as being equally controversial.

BACKGROUND

A Canadian communication entrepreneur, Edward Jarman, applied two years ago to the Canadian regulatory agency, the Canadian Radio and Television Commission (CRTC), that would allow his company, Northstar Home Theatre Incorporated, to utilize the Canadian Anik-C system in 1983. His application was denied in favour of a competing application, Can-Com Limited, that was to use the older 6/4 gigahertz band and older Anik satellites. Mr. Jarman's progressive activities have led him to be a part owner in a commercial U.S. operation known as United Satellite Television (UST) of New York. UST will be the first U.S. commercial broadcaster utilizing DBS and it will use the Anik-C footprint to offer a number of pay services to U.S. customers. Most of these customers are in noncabled areas and this is a substantial market. Even in Canada, one of the most cabled countries in the world, 22% of the population is without cable.

The following outlines the background of the Canadian satellite scene as well as the current controversy over the tilting of Anik-C for commercial reasons. In addition, it details the continuing struggle between cultural and economic objectives of satellite policy.

Before commencing on a discussion of the future of communications, it is important to bear in mind the role and example of Telidon. Telidon is a configuration of certain technologies, based on micro-processors, that permit remotely stored information to be transmitted to various Telidon terminals, whether they be in a living-room or in a public place such as a library or shopping mall. Telidon is symbolic of several important aspects of Canadian communication policy.

First, it entails government funding and government involvement in attempting to design a leading videotext technology. By contrast in the United States, the U.S. federal government plays a negligible role in developing videotext because the U.S. has sufficiently large companies, such as A.T. and T., I.B.M., General Electric, Xerox, Texas Instruments, etc. that guarantee a U.S. presence in the videotext sweepstakes. In addition, the large U.S. military budget is to a great extent a closet, government subsidized, hi-tech policy since it generates such extensive research and production of communication systems of all types.

Other nations, such as France, Germany, and Great Britain, are also developing their own government-sponsored systems in order not to become an information colony in the 21st century. Finally, Japan, through its large communication corporations, has also allowed the corporate side to develop the videotext technology while the government itself supports a communication strategy via Japan Inc. consistent with maintaining Japan in a major role, if not the major role, in the Information Age.

The second point is that Canada needs a successful Telidon-type technology to guarantee employment. It does make a difference whether future jobs are in Stittsville, a small town outside of Ottawa; or in Nashville, a major manufacturing area in Tennessee; or in Hawaii. If Canada does not develop its own videotext system that becomes a North American standard, then as the industrial jobs continue to decrease with the demise of the "smoke-stack" society, they must somehow be replaced by communication-related employment, or else employment will be both rampant and permanent.

Canada has long involvement with communications satellites, and an equally long-standing commitment to Canadian content in broadcasting to both rural and remote regions of the country, particularly in the North. DBS, the Anik-C satellite, has been heralded as a potential opportunity to reach more Canadians in remote and rural zones, until it was tilted. Documentation from Telesat reiterated this as a prime rationale for our involvement in DBS.

Traditionally, Canadian policy makers have viewed broadcasting as of special significance in its ability to build or alter the national sense of a Canadian identity. For example, the Broadcasting Act states that broadcasting should help..."safeguard, enrich and strengthen the cultural, political, social, and economic fabric of Canada..." It is anticipated that Anik C signals would be delivered in the direct-to-home mode, primarily where other forms of local distribution do not exist and are not particularly viable.

The Rural Communications Program... found that many communities surrounding the metropolitan areas were greatly under-served compared to those more closely located to urban centers...It was found that 24% of the population of Canada comprising 6 million people, live in rural areas...Rural communities now expect to obtain the same level of services enjoyed by urban communities... Some areas are suitable for cabling... owing to the density and linear structure of their communities. Other areas...are more widely dispersed and may be better serviced by Direct-to-Home satellite reception(4).

Applications involve "overcoming the constraints to social and economic development that rural Canada shares with many LDC's:

- difficulty in attracting adequate specialists and managers to remote areas...

- difficulty field personnel in remote areas have obtaining specialists' advice or consultation...

- difficulty in providing in-service training programs for remote area personnel...

- lack of culturally or regionally relevant broadcast programs or systems...

- lack of possibilities for inter-community communications among community leaders or groups with similar concerns..."(5).

On June 30, 1982, the Federal Department of Communications proudly announced that Communications Minister Francis Fox has given his approval to Telesat Canada for its contract to provide Argo Communications Corp., a U.S. satellite carrier, for six channels on the Anik-C satellite...

(Aug 26, DOC) Communications Minister Francis Fox and the Secretary of State for External Affairs, Mark MacGuigan, announced today that Canada and the United States have concluded an arrangement which will enable authorized satellite communications companies in both countries to negotiate agreements

with each other for the carriage of telecommunications traffic between the two countries by domestic satellites operating in the fixed satellite service...

The most immediate use for satellite services is expected to be for large business user networks carrying voice, data and teleconferencing traffic.

In a letter to the president of Telesat...Mr. Fox states that he will expect Telesat to negotiate agreements which achieve over time, use of Canadian facilities on an equitable basis, and proportional sharing of revenues(6).

Thus we see a move towards liberalizing communications between the two countries away from the 1972 Canada - U.S. Letters of Agreement which prohibited reciprocal use of satellites except in some exceptional circumstance. The renegotiations appeared to be headed toward the first stage of a continental information pact.

Questions of satellite transmission of TV services has been temporarily deferred while Canada decides the fate of Canadian content and how best to protect itself from the increasing diffusion of American culture, particularly pay-TV. The U.S. has different motives on the subject of DBS, strongly oriented towards strictly commercial interests.

Meanwhile, Oak Ltd. of California has rented two transponders on Telesat's Anik-C to focus on northeastern U.S. from Washington, D.C. to New York. They will use these until 1986 when they will switch to their own DBS. Anik-C will be tilted one-half a degree South to beam to the States rather than the one-quarter degree North required to service the remote North(7).

Telesat claims that tilting the satellites will not inconvenience Canadians. However, the Canadian Industrial Communications Assembly thinks that there is a greater demand for Canadian business services than Telesat realizes. Some argue that regulatory constraints have caused Canada to lag behind the Americans and it is predicted that soon Canada will depend on American satellites for pay-TV, DBS and other applications(8). Telesat officials admit that remote regions of Canada may be temporarily inconvenienced by the tilt of the Anik-C, but claims to have received no formal complaints. Yet there is the case of an educational user in Victoria, B.C. which claims to be faced with a six month delay in service solely because of the U.S. sales and tilting priorities.

Maps of the satellite reception contours based on the southward tilt show that while Atlanta would have a signal power rating of 38 Whitehorse

and Halifax would have a weaker rating of 35...As a result, users may have to install larger receiving dishes to pick up the signal, probably dishes 1.8 metres wide(9).

FOOTPRINTS, FREE-FLOW, AND CULTURAL SOVEREIGNTY

DBS footprints are not shaped to fit national boundaries. Spillover into other countries is almost inevitable. This has been an issue of major concern at international conferences on telecommunication such as the WARC and ITU. One extreme example is:

The Compagnie Luxembourgeoise de Telediffusion, the No. 1 commercial broadcasting operation in Europe, is set to launch a project that will hasten the demise of government-controlled TV monopolies in France and West Germany. By 1985, CLT hopes to be beaming television programs via satellite over the borders of half a dozen European countries into the homes of more than 100 million viewers. At stake is not only the prevailing European policy of government domination of the TV airwaves but also hundreds of millions of dollars in potential advertising that may switch broadcasters' hands(10).

Herbert Schiller outlines some of the issues surrounding satellite broadcasting in Communication and Cultural Domination(11). He notes that the operations and content of modern communication technology is dominated by a handful of multinationals, most of which are American, and most of which are interested primarily in revenues from commercial advertising. He also points out that free flow and freedom of information—that is, open skies policies—facilitate American culture and profitability on the airways. Open skies blatantly contradicts the Canadian policy of cultural priorities. The Canadian government is not totally unaware of the problem.

With all the force at our command, we urge the Government of Canada to take immediate action to alert the people of Canada to the perilous position of their collective sovereignty that has resulted from the new technologies of telecommunications and informatics(12).

At this point, there is little agreement on how TV signal spillover should be prevented, monitored, ameliorated, or compensated. In 1968, the United Nations Outer Space Committee Working Group showed the disparity between the U.S.A. position and other nations. The main vote was 100-1. The U.S. wished to discuss technology at the meetings while others, including Canada, wished to discuss social and cultural issues(13).

Competition with the existing distribution system

also works against the creative implementation of Canadian satellites. As far back as Spring 1979, William Melody suggested that the great social, economic and technological potential of satellites was and continues to be:

restrained by the need to accommodate the vested economic interests of the carriers that own and control the landline microwave and cable technologies. The history of satellites is one of wasted technical potential and outrageous economic inefficiency in order to preserve the near monopoly market dominance of the established telecommunications carriers.

Commercial applications of satellites have been undertaken with full recognition of the fact that, in terms of economic efficiency, satellites threaten the landline cable and microwave technologies. Intelsat—has followed policies which deliberately limited satellite development so as not to threaten the corporations and administration of the member countries with vested interests in under sea cable and landline technologies(14).

Thus, according to Melody, Telesat is designed to not threaten Bell Canada or TCTS, who now actually control Telesat by a controversial decision.

In sum, Anik-C and DBS have not only ushered in an era on new satellite technology but these new powerful systems have brought with them several controversial decisions with various stakeholders taking opposing positions. The tilting of Anik-C for commercial reasons is supported by Telesat and TCTS whereas others are perplexed as to why Northern Canada is still underserved by Canadian common carriers. The wide-spread use of "illegal" earth-stations to pick-up U.S. broadcasting services reflects this vacuum in available Canadian alternatives.

There is little doubt that Anik-C will bring wind-fall profits for Telesat-TCTS but the cultural erosion of Canadian communication objectives by advancing technologies is a continuing problem for Canadian policy-makers and citizens alike.

ENDNOTES

(1) The FCC has issued twelve DBS licences to U.S. corporations but the first operational system is not expected until 1986.

(2) For further details see T.L. McPhail, Electronic Colonialism: The Future of International Broadcasting and Communication (California: Sage Publications, 1981).

(3) There is a considerable demand in Northern Canada for television service. There are approximately 4,000 illegal earth-stations in Canada's North pirating U.S. broadcasts from U.S.

satellites.

(4) Telesat Canada, Study of the Use of Anik C for Direct-to-Home and Community Television Distribution Services. E.S.I.I.-2. Government of Canada. Department of Communications, 1 Sept. 1981.

(5) Development Communications Report, No. 26, 4.

(6) June 30, 1982 - Francis Fox, DOC Press Release.

(7) Chevreau: Globe and Mail, March 5, 1982:B4.

(8) Chevreau: S. Bell Globe and Mail, March 29, 1982:B6.

(9) Ibid.

(10) Business Week, May 4, 1981:25.

(11) Schiller, Herbert, Communication and Cultural Domination. (White Plains, N.Y.: Sharpe Inc., 1976:40).

(12) Telecommunications and Canada, Canada's Consultative Committee on the Implications of Telecommunications for Canadian Sovereignty, 1979:76.

(13) For further details see: Signitzu, B., Regulation of DBS; the UN Involvement:28-47 and Laskin and Chayes, Society, v.12, September 75:6.

(14) William Melody, "Are Satellites the Pyramids of the 20th Century?", In Search, Spring 1979, Vol. VI, No. 2:4.

A CRITICAL APPROACH TO U.S. COMMUNICATION POLICY: 1983

Deanna C. Robinson
Department of Speech
University of Oregon
Eugene, Oregon

The free enterprise system of the United States enables the country to be a world leader in development and marketing of information-age technology. However, the lack of central government planning in respect to how and why such technology is developed and implemented may prevent the United States from demonstrating potentially beneficial social consequences of this technology. Emphasis on deregulation and substitution of "marketplace competition" for the previous regulatory criterion of "the public interest" appears to be producing an incoherent body of minor "administrative" decisions and obscuring, or even preventing, consideration of larger "critical" questions related to the absorption of information technology into the overall social structure.

In the following paper I analyze how the introduction of telecommunication and computer technologies differs from the introduction of older communication innovations. I then raise some questions about what is happening in respect to the old regulatory values of universal service, fair price, diversity and localism. Finally, I speculate on some highly negative social consequences that may arise as a result of inadequate, piecemeal consideration of what has been called the communication revolution.

The Introduction of Older Communication Technologies

The industrial revolution took less than one hundred years to change the U.S. from an agrarian society to an industrial one. The communication revolution may be occurring even more quickly. In 1950 twice as many workers were employed in the industrial work force as in the information sector. If we regard the development of the transistor in 1948 as the beginning of the information age, the fourth great ordering of society (after hunting, agrarian, industrial) is now about three decades old. By 1978 twice as many workers were employed in the information sector as in the industrial work force (37). The rapid introduction of "telematic" or "comunication" technologies during the past thirty years differs radically from the introduction of industrial-age communication technologies.

Telegraph, telephone and radio (including, subsequently, television) were introduced individually in the U.S. The establishment of their infrastructures were separated by half-centuries of time as well as clearly-defined functional differences. Telegraphy began in the mid-1880s and connected communicators over distance. Telephone began in the early 1900s and connected communicators for a period of time, a functional distinction discussed by both Innis and Smythe (24,39). Radio broadcasting began in the 1920s, TV in the 1950s as a nationally-available system. Both broadcasting media connected a few communicators to many listeners simultaneously. Because of their distinctive functions, the infrastructures of these innovations did not need to be integrated with one another or added on to any preexisting communication structure (38).

Because each technology was unprecedented in its apparent function, the major concern of policy-makers did not have to be how to fit it into an existing system protected by vested interests and regulatory precedent, but rather could be what part the innovation should play in the larger social structure. Thus, even though congressional action in respect to radio was necessitated by industry inability to solve interference problems, the Radio Act of 1927, the first American act applicable to broadcasting, emphasized broadcaster responsibility to the public. A major purpose of the act was to formulate a criterion that could be used to determine who among competing parties for a broadcast license would be awarded the license. This criterion was stated as the party who would best serve "the public interest, convenience and necessity." This standard was based on the concept of public ownership of the airwaves and the consequent belief that broadcasters ought to serve the owners of this natural resource equitably, i.e., that broadcasters held licenses in trust for the general public (41, 56). The promulgation of the policies of diverse and locally-oriented service followed naturally from the 1927 Act's general reasoning (e.g., 42, 10, 11). These principles were recodified in the Communication Act of 1934 which achieved the further goal of placing common carriers under the same regulatory umbrella as broadcast media, the Federal Communication Commission (43). Unlike the pattern in most other countries, most common carrier and broadcast media are not publicly- or government-owned in the United States. Since the inception of telegraph, communication entities have been treated as private enterprises. However, they have been regulated, broadcast media by the licensing procedure and common carriers by rate of return. Thus, common carriers, similarly to the principles of

media regulation, could be required to provide universal service at reasonable rates. Congress reinforced the goal of universal common carrier service by an extension of the Rural Electrification Act to telephone. Finally, although the functions and infrastructures of the three technologies were separate, the beginning of the 1934 Act does express the concept of an integrated system:

For the purpose of regulating interstate and foreign commerce in communication by wire and radio so as to make available, so far as possible, to all the people of the United States a rapid, efficient, Nationwide, and world-wide wire and radio communication service with adequate facilities at reasonable charges ... there is hereby created a commission ... (43, p.513).

These principles of universal service, fair price, diversity, localism and system integration are being obliterated by current policymaking that emphasizes encouragement of marketplace competition. Some critics say the principles were never applied well anyway, but at least they provided a socially conscious framework within which policy had to be justified. At present, many policymakers perceive the public interest as lying within marketplace competition, that competition per se is the public interest (e.g., 51,20). The concomitant deregulatory mood results from a desire to get a sluggish economy going again but also from a highly complex regulatory and technical situation surrounding the introductions of newer communication technologies.

The Introduction of Newer Communication Technologies

Differences between the two traditional views of social change, technological/economic determinism and ideological control, have been examined elsewhere (e.g., 37) and will not be explicated here. However, a few brief remarks are necessary in order to set the theoretical framework for this paper. The forces behind technological/economic determinism are technological change and the modes of production accompanying that change. The major agents of ideological control in respect to our discussion of communication change comprise the FCC, Congress, the Courts, the regulated industries, the White House and consumers (see 27). The driving force behind ideological control in the United States is capitalism. I believe that, despite overwhelming technological/economic forces at work in a society, people have some free will and, therefore, political interests can vie on behalf of ideological as well as administrative differences. I see disagreements and decisions within the present capitalistic system as "administrative" in nature. They represent issues that arise in relation to maintenance of the established structure. Most decisions, if not all, currently being made in American communication policy are of this type. The problem is that the transference from an industrial age to an information age requires structural changes in society.

Thus, what is needed is a more "critical" approach, an examination of what is happening in relation to the overall social structure. The theoretical framework for this paper, therefore, acknowledges the interaction of technological/economic determinism and ideology but only if ideology is defined in the larger sense and removed from the administrative level of decisionmaking (for further discussion see 32). Given this approach, I see the present situation as comprising highly complex political and technological factors. Piecemeal approaches to dealing with these factors serve to obscure an examination of the possible consequences of blind acceptance of laissez faire capitalism for American society at this time of great change.

1. The Technological Context.

Two major differences exist between introduction of telegraph, telephone and radio in the U.S. and introduction of subsequent electronic technologies. First, the latter are being introduced rapidly, simultaneously and some of them are undergoing many machine generations in the space of a single human generation ("transient" technologies). Beginning in the 1950s with the introduction of cable television and computers, new telecommunication media, common carrier technologies and computer-linked innovations have been developed rapidly, e.g., satellite communication (both point-to-point and direct broadcasting), video disc and cassette, fiber optics, silicon chips (culminating in LSI microprocessors), robotics. New uses for older technologies add to the complex array, e.g., videotext, teletext, cellular radio, interactive cable and optical wave guides, multiple distribution service, high-definition television. Combinations of telecommunication and computer technologies ("telematics" or "compunications") provide additional innovation, e.g., video games and personal computer hook-ups to telephone lines through modems. Transient technologies provide a further complexity factor, e.g., computer technology beginning with the transistor and ending with the microprocessor. This technological evolution has enabled information processing capacity of computers to increase by five factors of ten (100,000 times) between the 1950s and 80s. A 1950 room-sized computer now can be replaced by a thumbnail-sized computer capable of processing more information (1). Satellite technology has changed similarly.

Satellite technology provides an example of the second difference between the introductions of older and newer communication technologies. The functions of newer technologies are multiple, overlapping and dynamic. Satellites can be used for long-distance telephone, video and data transmission, for direct broadcasting and, now that technology has made possible the combination of high-powered satellites and small earth stations, satellites can function as switchers in a communication system, i.e., send a received signal to any of many earth stations. Such a system eliminates the three most costly terrestrial system

components, switching equipment, redundancy (necessary in case of failure of one part of the system) and tails (the "last mile" of transmission) (1). Similarly, multiple channel coaxial cable or optical wave guides (fiber optics) add to cable television's accustomed broadcaster-like function the traditional common carrier function of two-way, interactive communication. Another example of merging functions is the availability of telephone lines for "electronic publication," a possibility found very worrisome by the American Newspaper Publishers' Association.

This complex technical situation contributes to the equally complex political situation because, unlike older technologies, the new ones have to be added to an existing system with regulatory and practical precedents as well as self-protective vested interests afraid of unknown and potentially substitutable competition.

2. The Political Context.

Recent regulatory activities in respect to the telephone and cable television industries illustrate the complex political context of current regulation. In both cases regulatory action was necessitated by fear of competition from other entities and involved policy participation by multiple parties.

The Department of Justice launched a suit to break up the vertically-integrated Bell Telephone System (AT&T) in 1956. The immediate result of that effort prevented AT&T from entering into "unregulated" communication markets. AT&T, therefore, was constrained from marketing what its Bell Laboratories developed, a considerable curtailment because the Bell System spends more than one billion dollars per year on research and development (52, p. 166). As the information age cut more deeply into the American industrial economy, some policymakers saw this constraint upon AT&T as hampering the growth of information-related services and products. Another aspect of the situation was the increased internationalization of communication markets and the U.S. need for adequate representation within that arena. Meanwhile, other communications firms remained fearful of an AT&T entrance into unregulated markets, because of the possibility of cross-subsidization of unregulated endeavors by regulated activities. These conditions produced renewed interest by the Department of Justice in a break-up of AT&T rather than reliance on functional constraints. The Senate and the House of Representatives also began work on reregulation of common carriers and the FCC continued to hand down decisions affecting AT&T (53, 51, and e.g., 19). In January 1982 the Department of Justice and AT&T came to an agreement whereby AT&T would be permitted to enter unregulated markets but would divest itself of its twenty-two local telephone service companies (49). The Senate, just the month before, had passed a telecommunication bill that now required revision in light of the consent decree (53). A parallel

House bill (the "Wirth" bill, named after its prime proponent) continued to be considered and dealt with many of the same subjects as the consent decree, one of which was whether or not local telephone companies would be permitted to keep telephone directory advertising revenues (51). The Bell System objected to aspects of the Wirth bill and launched a two million dollar lobbying effort to defeat it. In the face of this assault, Wirth decided that the bill could not pass in that session because of the delaying tactics of AT&T and it was dropped. Consumer protests about the consent decree continued up until the time a Federal judge accepted it but were largely ignored by all parties to the activity (57).

A similarly complex regulatory effort is illustrated by the evolution of control over cable television. The FCC, after waiting for Congress to provide direction in respect to agency jurisdiction over cable (then commonly referred to as community antenna television, CATV), simply assumed authority over what was seen in the early 1960s as a technological extension of television signal coverage (12). The agency extended regulation as cable became a medium in its own right even though its status as a common carrier or broadcaster (cable has been referred to as the "amphibian" of communication technology) remained ambiguous (13, 14). The FCC was joined by the courts at the end of the 1960s in protection of local broadcasting stations from possible economic harm due to importation of distant station signals and potential fragmentation of the advertising markets for local stations (46). In the early 1970s a newly-created agency of the White House, the Office of Telecommunications Policy, brought together representatives from the cable and broadcasting industry to work out an agreement whereby cable would abide by restrictions on its programming in return for permission to import some distant signals into major markets (15). The FCC then was "encouraged" to promulgate matching regulations (16). These rules, along with the high interest rates charged cable companies in the early 1970s, nearly caused the death of the new medium and retarded its development until the courts lifted some of the rules and satellite technology made possible more efficient long-distance transmission of video (47, 29). Cable is largely unregulated now except for remaining "must carry" rules applying primarily to local and educational signal carriage and franchising rules. The latter may be struck soon. The Senate currently is considering a bill to remove franchising restrictions upon cable companies (54). The major opponent of this bill is the National League of Cities but, like the citizen efforts in the case of the telephone consent decree, the NLC is unlikely to have much effect.

The mix of these players adds up to a highly dynamic and ambiguous regulatory situation. A huge bureaucracy has grown up since the 1934 Act to deal with the extensive infrastructure and its accompanying vested interests. Parties to the

established structure do not want change unless it benefits them. Members of the status quo are extremely powerful as attested by the demise of the Wirth bill and the influence of the broadcasting industry over cable development.

Not only are many more entities with bigger stakes involved now than in earlier decisions but most parties have established sets of regulation and practice behind them. Because most of the principle advocates for these parties are lawyers, consideration of precedent constitutes a strong factor. What has been done is frequently seen as what should be done despite radically different contemporary considerations (27). Thus, the tendency is to ask questions applicable only to how to keep the current system running and to ignore the implications of a new social ordering termed "the information age."

Critical Questions

As can be seen from the above discussion, the combination of a highly politicized regulatory context and rapidly-changing, multiple and competitive technologies presents a nightmare of complexity for policymakers. The U.S. response to this complexity has been to ignore larger implications and respond to vying political/economic entities by minimal administrative regulation. This regulation represents the minimum degree of governmental "interference" and, supposedly, will stimulate the economy through unfettered marketplace competition. The old values of universal service, fair price, diversity and localism are assumed to be embedded in a highly competitive marketplace. For example, policymakers assume free enterprise will serve most people eventually with a diversity of conduits and content. This approach represents extreme technological/economic determinism. "Let the marketplace decide" appears to be an objective regulatory stance. But as Auerbach says "this is itself an ideology ... one so pervasive as to be almost invisible" (4, p. 8). Auerbach advocates intentional design of an overall communication system to meet defined public goals, the attainment of which he sees as improbable "in the absence of some governmental guidance or structures" (4, p. 10). I am inclined to go one step further than Auerbach. I think that if some central planning does not take place, we risk at least three very negative consequences.

1. The values of universal service and fair price may be largely ignored with the result that information-based classes may appear.

The current marketplace fails to offer universal service in new technologies for two reasons: geographic location and inadequate customer income. People who live in rural or poor areas are not well served, e.g., by cable television. The argument can be advanced that, despite stated intentions of the government, rural areas have never been served equitably by communication channels. People in these areas cannot receive as many

broadcasting signals as their urban peers and their telephone system equipment is usually the most outmoded in the country. But the reason they have the service they do is that the government intervened in the free market to provide it. The FCC's early policy of clear channel radio stations provided rural service until local stations could survive economically. Television stations were licensed on the first priority of at least one TV service to all parts of the U.S. followed by a second priority of at least one television station to each community (31). The Rural Electrification Act was extended to help provide rural telephone service.

Recent policies, formulated and proposed, threaten universal service. The AT&T/Department of Justice consent decree separates local Bell operating companies from AT&T. John Bryson, President of the California Public Utilities Commission, says "the impact of divestiture will mean a very significant increase" in rates charged by Pacific Telephone and Telegraph Company, the largest of the local Bell System companies to be divested (23). Arthur Latno, Jr., Pacific Telephone's executive vice president for external affairs says that unless Pacific Telephone gets its requested rate relief, the company will have to cut the quality of its service (23). A report prepared by an Oregon Public Utility Commissioner and that state's Attorney General argued that the BOCs would be hurt by the loss of cross-subsidization from long-distance revenues as well as income from the "yellow pages" (directory advertising) (26). Judge Harold Greene who approved the consent decree did modify it so the BOCs would retain yellow pages revenue. Nevertheless, the BOCs will no longer be able to rely on AT&T's expertise in capital acquisition, marketing capabilities (until divestiture the Bell System had the largest marketing organization in the world), construction, operations and short-term loans. What effects divestiture and the new competition expected in local loop service will have on the BOCs is not determined. The Wirth bill in the House had set up a National Telecommunications Fund to provide financial protection for small exchanges but that bill is now defunct (51).

Local television stations are threatened on many fronts: the cable "must carry" rules may be dropped, cable companies will win an increasing number of ads once a cable rating system is worked out satisfactorily for advertisers, direct broadcasting from satellites may further fragment local station audiences. Network viewing is down 2.2% in the first four weeks of the 1982-83 season. Although no one is certain why this drop has occurred, it will affect affiliate's advertising sales as a result of decreased circulation (7).

In the past libraries have not been related to an electronic communication market. Library users currently are subsidized by non-users who pay

taxes to support libraries as storage systems. If libraries become mostly electronic print-out sources, then users will probably pay for document copies directly (9). Many free or low-cost services may be affected by a newly competitive situation, e.g., major sports events may be sold to consumers on a pay-per-view basis rather than being aired over commercially-supported TV, physical delivery of the mail may become economically unfeasible in the face of electronic mail competition, local telephone calls may be paid on a per-call rather than monthly flat-rate basis (in the past, heavy local-call users have been subsidized by light users). The new services which replace the old will not only require money for content but frequently will require purchase of additional conduit equipment, e.g., a personal computer, modem, cable hook-up.

Both these constraints, lack of universal service and high cost, could result in a two-class society comprising the information haves and the information have-nots. Accessibility to communication services will be a fringe benefit of high income and appropriate location rather than a basic right in a democracy. Another facet of denied access is more subtle--lack of opportunity or ability to develop functional literacy in information search and processing (see 37). Children who grow up in poor neighborhoods and attend schools without computer terminals or teachers trained to teach information-age skills may never learn how to function in an information society. Even if these people are given access to communication channels and content as adults, they will benefit little from the new technology. Those people who are able to make astute use of and who have access to the myriad channels of the future are those who will be in charge of the system.

2. The values of diversity and localism may deteriorate and damage our concept of democracy.

In terms of horizontal integration, the communication sector of the U.S. has been fairly concentrated. Unlike the trend toward concentration in other sectors, horizontal communication concentration may decrease in the face of new competition. However, opening of communications markets will occur in the wrong place for a democracy, i.e., in conduit rather than content. Furthermore, competition is likely to adversely affect the concept of local control.

AT&T has always been the "dominant" carrier in the U.S. For the period between 1967 and 1979, the Bell System's proportion of total domestic telephone revenues, plant and employees was above eighty percent (52, p.55). In 1977, AT&T's gross revenues of thirty-six billion dollars exceeded the GNPs of 118 of the 145 members of the U.N. (37, p.25). MCI, the leading specialized carrier, has a less than one percent share of the long-distance market revenues. However, competition

does now exist in long distance telephone communication and is expected to increase there and to become part of local loop service as well.

Multiple ownership of broadcasting facilities has been limited by the "seven-seven-five" rule (seven radio stations, seven total TV only five of which can be VHF stations). Despite this constraint, the sets of five stations owned by the national TV networks each reached over one-fifth of television homes in 1980. Metromedia and RKO TV stations reached twenty and seventeen percent of all TV homes respectively in that same year (52, p. 285). The television station market will become less concentrated as a result of VHF drop-ins, carriage of UHF signals on cable systems (which puts UHF on a more equal footing with VHF) and low-power TV stations.

Radio ownership is quite diffused. In 1976 just seventeen owners held the maximum number of seven AM or seven FM stations. Only seventy owners held five or more stations and altogether those owners controlled not more than ten percent of the commercial stations in 1976 (52, p.277). Radio will obtain more stations through the break-up of clear channel allocations.

Cable ownership is more concentrated. In 1981 the top ten multiple systems owners (MSOs) had over fifty-eight percent of cable households. Fifty MSOs had over eighty-five percent (21, p. 87). Cable competition takes place among nationally-owned companies. Thus, even though exclusive cable system franchises may be struck down by a Colorado court soon, potential local level competition probably won't affect the overall concentration ratio (58).

In 1969 the Justice Department launched a suit against IBM saying the company had monopolized the general-purpose computer market. That suit was dropped at the same time the 1982 AT&T consent decree was announced, a decision that may encourage IBM to acquire additional companies and expand into other markets (2). Analysts estimated in 1982 that IBM controlled seventy percent of the mainframe computer market (2). The mini computer market is more competitive (twenty percent IBM). AT&T's entrance into unregulated communication markets should encourage competition if AT&T is prevented from cross-subsidization of one service by another.

Thus, horizontal integration is not an immediate problem in communication. This fact obscures a more important type of concentration, that involving vertical integration, especially single company provision of conduit and content for any given type of service. The most disturbing aspect of the commercial television system in the U.S. has not been scarcity of channels but rather the strangle-hold three networks have had on access to those channels by independent suppliers of content. The FCC and the Department of Justice have tried to combat this centralization repeated-

ly (17, 18, 48). A recent suit by the Justice Department restricts the amount of primetime programming TV networks can produce (48). However, the networks also determine which independent companies can produce for primetime TV. In 1978 the top eight production firms produced almost forty-nine percent of the series and commanded fifty-three percent of the audience. The leading twenty firms shared seventy-four percent of the series and eighty-one percent of the audience (52, p. 287). Network programming dominance does not continue just because the networks own five major TV stations a piece but is perpetuated through tight affiliation contracts with stations. Out of 765 commercial television stations the three networks are affiliated with 596 (the rest are independents and they carry many off-network programs).

Cable television was hailed as the end to network domination of content and the necessity to "broad" cast. Cable television was supposed to "narrow" cast and, thereby, serve a wider variety of tastes and needs. Pay-cable was especially heralded as a narrowcast service. Yet pay-cable has become a particularly egregious example of program domination through vertical integration ownership and affiliate contracts. Litman and Eun (29) build a strong case for excessive concentration in pay-cable program supply. The following information applies to 1980 data and, although the pattern of control is the same, details of ownership have changed (e.g., 28).

Home Box Office (HBO), the largest programme distributor, with some 4.1 million subscribers and nearly 55% of all pay-cable business, is vertically integrated with American Television and Communications Corporation (ATC), the second largest MSO. Both HBO and ATC are subsidiaries of Time, Inc. Showtime, the second largest programme distributor, with 2 million subscribers and 26.7% of the market, is co-owned by Teleprompter, the largest MSO, and Viacom, the sixth largest MSO. The next largest programme distributor, Warner's 'The Movie Channel', has a vertical link with Warner Communications, the third largest MSO. Together, these three giant distributors constitute almost the entire programme distribution business and have exclusive vertical ownership ties to MSOs covering 21.5% of all cable subscribers (29, p. 124).

Program distributors may feel further purchase of cable systems is unnecessary, however, because, as with broadcast networks, favorable affiliate contracts provide sufficient control over outlets.

In addition to vertically integrating, many communication companies are diversifying their interests, a trend Murdock and Golding regard as very dangerous (32). Companies no longer want to place all their bets on development of one

type of technology in such a complex mix of competitive possibilities. An example of such diversification is provided by the recent merger of Teleprompter and Group-W, a conglomerate with broadcast and cable holdings as well as program production and distribution. Showtime was owned half by Teleprompter and half by Viacom. Group-W wanted to buy Viacom's half but could not do this, so sold its half to Viacom. Viacom is now trying to sell its new half to film production companies. Other movie companies have indicated interest in buying into the Movie Channel. The FCC currently is considering permitting broadcast networks to own cable systems (special permission has been given CBS to do this already on a limited basis). The only entity that most other communication industries and the FCC want to keep out of media conduit and content is the telephone company (21).

Dunn states that "the tendency to combine the provision of distribution service, which is often a local monopoly, with the provision of content, may reduce the competitiveness of the market for content" (9, p. 22). Cable is estimated to be installed in thirty percent of TV homes. Because of the franchising process, no community has more than one cable system. If a person's TV is hooked to cable, then the cable company determines everything the viewer sees over that system with the exception of "must carry" channels and access channels. Owen, Beebe and Manning, Jr. argue that simply having more channels does not mean greater programming diversity (35). Both monopoly and competitive program suppliers will split the large, common denominator market until the portions of audience reached are so small that a second type of program draws more viewers. This is certainly true in the case of advertiser-supported programming. CBS recently spent fifty million dollars starting and operating a cultural cable-TV service which was supposed to be supported by advertising. After eleven months the company announced it was folding the operation because of inadequate support. The demise of this service caused industry members and analysts to question whether narrow, high-quality programming is feasible (30). Owen, Beebe and Manning, Jr. see pay-TV (or pay-cable) as the hope for programming diversity (35). Yet right now the pay-cable program supply industry is completely dominated by only a few firms who are linked closely with affiliates. This situation is hardly that envisioned by the heralders of the new media abundance.

The concept of localism is related to diversity of programming. Stations used to be required to consider local tastes and needs when planning their programming schedules (44, 11). But service for local tastes and needs depends upon two things, choice in programming on the part of the station or cable system, a condition that doesn't apply as argued above, and local consumer voice in program decisions. Since a 1966 court ruling, broadcast consumers have been given a minimal opportunity to express dissatisfaction with a local station's performance during the station's license renewal proceeding (45). This opportunity has been

slowly eroding during the past few years as more and more adjustments are made to licensing per se. The Supreme Court has said that the FCC does not have to consider the public interest effect of radio station format regardless of whether citizens complain, for example, that the community's sole classical station is about to become another rock station. The FCC's radio deregulation released stations from the obligation to carry a specific percentage of public affairs programming, frequently local in orientation (5). Congress instructed the FCC to use a lottery for assignment of new licenses rather than comparing attributes of competing applicants. Several bills in Congress now call for an end to comparative hearings in contested license renewals and automatic renewals for incumbent licensees. License terms have been extended from three years to five for television and seven for radio, so consumers have less frequent opportunities to complain. This decrease in voice opportunity probably won't apply for long anyway because the present chairman of the FCC favors doing away with licensing altogether (6).

The franchising process used to afford cable consumers an opportunity to make their wishes known in respect to how their local company should operate. An erosion of this minimal control parallel to that in broadcasting is happening. Communities already are not permitted to set rates for any cable programming other than what is called "basic service." Cable owners "tier" their other offerings so consumers must pay extra for each additional group of channels they wish to receive, including pay-TV channels. Thirty dollars per month is now an accepted charge for individual consumers to pay. A current Senate bill calls for removal of a community's right to determine even basic service rates or the range of services offered by the cable company and the number of channels to be provided (54). The entire franchising process may end as the result of a suit filed in Colorado against the city of Denver that says the city's cable TV franchise is unconstitutional because it deprives residents of the right to competitive cable service, therefore abridging their First Amendment rights to receive information (58). Perhaps this will lead to a competitive cable situation but that is doubtful because of the expense involved in setting up systems and the fragmentation that would occur in terms of the paying audience. If two or more cable companies were to operate in the same location, they would be likely to offer the same types of programming given the anti-competitive program supply situation. Two systems of forty channels each will have little value if viewers still do not get their program desires satisfied. As Auerbach states, "a consumer cannot choose what is not offered, no matter how desirable the choice may be" (4, p. 8).

Communities have never had a say over their telephone companies except in respect to public utilities regulation. Now that competition will be introduced at all levels of the telephone system,

including the local level, differentiations in services offered are certain to appear and some of these will fall into unregulated markets. These will be outside consumer control but will affect the economic well-being of the local loop company. For example, AT&T and GTE plan to offer cellular radio telephone service in the thirty largest U.S. markets. Other markets won't have this service available for consumers and those that do may see a deterioration occur in their basic telephone service as a result of possible competition from this innovation.

The United States has always believed strongly in the concept of local control. The country is a collection of states; public schools are financed and administered locally; police powers are also locally determined. The idea of localism represents respect for diverse needs and desires. Only through local control can individual communities around the country protect their own interests rather than having them dictated from the nation's capitol. Without adequate communication a democratic society cannot function. People have to have access to many sources of information and they have to be permitted to say what their information needs are. Given the present regulatory context, communication industries will market the most profitable services over the most profitable routes to the most profitable consumers. Those who are left out or those who are otherwise dissatisfied will have little to say over what is the most important infrastructure in a democracy.

3. Lack of central planning for changing conditions may contribute to future unemployment.

In the microelectronic era, one hears the observation that firms grew so fast that they were required to move to smaller headquarters ... (25, p. 29).

Unemployment is at 10.1 percent—but it's due only partly to the recession. A revolution is under way: the smoke-stack industries are shrinking—leaving millions without the skills to compete in the emerging high-tech economy (3, p. 78).

In 1962 Machlup estimated that thirty-two percent of the U.S. labor force comprised knowledge production workers (37). In 1978 Porat judged forty-six percent of workers to be in information-related jobs. As far back as 1967 Porat considered fifty-three percent of total employee compensation to go to information workers (37). At that time he also argued that forty-six percent of the GNP was associated with what has been termed the "quaternary sector."

New technologies are having a profound effect on traditional jobs. In 1968 the Letter Carrier's Union had 600,000 members. Many of them will be laid off if the Post Office begins to provide the electronic mail service it will probably have to in order to compete with private industry.

General Motors plans to purchase 14,000 industrial robots by 1992. These robots may put as many as 50,000 workers out of jobs (3, p. 80). Robots will not do just repetitive jobs in factories but will perform in fairly sophisticated ways. For example, security robots serving as plant sentries may be common within five years (8).

In addition to the direct effect of information-age technology on jobs the general transference from an industrial society to an information society is causing dislocation of workers. For example, as many as 200,000 auto and auto-supply workers may lose their jobs permanently not just because of temporary lay-offs (3). Some of these workers will get other jobs, perhaps even information-related jobs if they are retrained. They are likely, however, to get service jobs at lower wages than they were earning as skilled blue collar workers. An indication that such jobs are available is the fact that for the first time in American history a larger percentage of the male work force is unemployed than female (33). Females still make up the bulk of service sector workers.

Another less obvious effect of new technology on the American labor force is the moving of office work abroad. Just as factory work has been taken to countries with cheap labor so now are white collar and technical work being farmed out abroad (36). This change results from satellite technology which permits typing in of information to a computer in one location, instant transmission to and printing or storage at another location. Satellite Data Corporation pays Barbadians \$1.50 per hour for word processing and data entry tasks that would demand \$4 to \$12 per hour in the U.S.

The effect on jobs of industrial-nation movement into the information-age is a global phenomenon. As of fall 1982, both Britain and Canada had unemployment rates close to thirteen percent. The World Bank says that slow growth and high unemployment will characterize the 1980s in industrial nations and worsening poverty will strike the poorer countries (40). The bank believes the world economy is in trouble because of industrial countries' restriction of money and credit growth to curb inflation. Undoubtedly, these are major factors in the current global recession but they gloss over the deeper threat to the world economy and that is simply the changing nature and perhaps decreasing availability of jobs per se. A French report estimates, for example, that computerization could destroy thirty percent of French jobs in banking and insurance (3).

New jobs to come are not predictable, their evolution is slow and people have to be retrained for them. Furthermore, future occupations may require skills that preclude some people from ever being able to do them. The argument advanced above about information haves and have-nots in relation to functional literacy is applicable here. Even for those with high potential, help must be provided in retraining. According to

Victor Walling, manager of the business futures program at SRI International, "a growing number of experts are convinced that government is going to have to intervene to relieve the transitional pain through job retraining, relocation assistance and possibly even an expanded program of public works" (quoted in 3, p. 78). Treasury Secretary Donald Regan agrees with the idea of government help in retraining if unemployment is ever to be brought below six percent again (34). In October 1982 a multibillion-dollar job-training bill was passed in Congress. It will provide programs for at least a million people per year. Congress is expected to consider a multibillion-dollar public works program to create immediate jobs in the coming session (22). While certainly these are moves in the right direction, Congress still fails to recognize the scope or source of the problem. It does not acknowledge the connection between a policy of laissez faire free enterprise in the development and implementation of information-age technology and the uncontrollable increase in unemployment. An integrated view of communication developments has to include questions about the rate and desirability of innovation in certain labor-intensive fields, e.g., the Post Office and General Motors. These considerations and others mentioned above demand a macro-level, critical examination of what is happening in the United States rather than piecemeal attempts to deal separately with different technologies, different markets and different areas of social concern related to the transitional period.

A Somewhat Encouraging Note

A 1978 attempt by a California Congressman to rewrite the 1934 Communication Act did try to see the larger communication picture, if not its relation to the overall social structure (50). That bill was unacceptably sweeping at the time and the Congressman lacked sufficient political clout. Another bill is now being considered in the Senate sponsored by a Senator with considerable power, Goldwater of Arizona. Ironically, Goldwater is a conservative utterly in favor of free enterprise and opposed to government intervention in business. His bill, S. 2469 (55), the purpose of which is to provide for improved international telecommunication, begins by reiterating this philosophy of competition as efficient provider of diverse services. But it does two very significant things related to the above discussion. In Title I it sets up a "National Communications System" to "ensure the provision of necessary telecommunications to the Federal Government under all conditions through the linking together of telecommunications facilities, components, and services of each specified agency," a tacit recognition of the need for an integrated communications system put together by centralized authority even if only for the benefit of the government.

In Title II the bill recognizes that "the United States has no coordinated international tele-

communications and information policies" and that it must have an "effective mechanism" to coordinate activities "within the Federal Government and between the Federal Government and the private sector." It creates an International Telecommunications and Information Task Force to act as this mechanism. Two specific assignments of the task force are to 1) "conduct a comprehensive study of the long range telecommunications and information goals of the United States, the specific telecommunications and informations policies necessary to promote those goals and the strategies that will ensure that the United States achieves them" and 2) "conduct a review of the structures, procedures, and mechanisms which are utilized by the United States to develop telecommunications and information policy." The purpose of this particular bill is to ensure a leading position for the U.S. in the world communication markets. But the wording of the bill, as quoted above, could just as well serve to promote a critical examination of all U.S. telecommunication and information policies in order to define and promote social goals applicable both internationally and within U.S. boundaries. The Goldwater task force ought to be expanded to include creation of an integrated communication system for the people of the United States and an analysis of the long-range telecommunications and information goals within this country as well as abroad. As it stands now, the bill promotes the interests of the Federal Government and private industry while completely ignoring the growing problems of a society in transition and the interests of the American public.

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The Evolution of Telecommunications Policymaking Structures and Processes in New Zealand During the Period 1960-1978

Graham A. Wagner
New Zealand Council for Educational Research
Wellington, New Zealand

1. Abstract

During the last two decades the traditional roles of the two major providers of telecommunications services have undergone changes brought about by internal and external economic, political, social and technological pressures. This paper, using case studies research, describes the 'change agents' and formal structures involved in telecommunications policymaking processes noting the move towards, and need for, a coherent national communications policy.

2. INTRODUCTION: SETTING THE SCENE

New Zealand, along with other industrialised OECD nations, is fast becoming an information society based upon an information economy.(1) In the past we recognised three occupational sectors (agriculture, industry, and service), but now we include a fourth sector which we call the information sector. This sector, which includes information production, processing, and distribution occupations, made up 35.9% of the New Zealand workforce in 1976. Table 1 indicates a steady growth in the number of information workers in New Zealand over a twenty two year period, a major feature of developed countries in recent years.

Table 1. TIME CHANGES IN THE NEW ZEALAND WORK FORCE

Occupational Sector	1954	1961	1966	1971	1976
Agriculture	16.4	14.5	13.1	11.6	10.4
Industry	36.2	36.0	35.6	34.0	33.1
Service	21.7	20.5	21.0	20.6	20.7
Information	25.7	28.9	30.3	33.7	35.9

Source: Conway (1981)

Compared with three other Pacific Basin countries New Zealand has been moving along at a fast pace, exceeded only by the United States of America. Table 2 demonstrates the change in composition of the work force in the post World War II period.

New Zealand has always been very quick in following overseas trends in communications technologies. "The telephone was introduced only a matter of months after it had been invented; Parliamentary debates were broadcast decades before they were in Britain; local radio likewise was a major feature of the New Zealand broadcasting system long before it was the case in the United Kingdom.(2) The use of communications technology to help further the early

Table 2. CHANGES IN COMPOSITION OF FOUR PACIFIC BASIC COUNTRIES WORK FORCES

Pacific Nation	Information	Service	Industry	Agriculture
USA				
1950	30.5	19.1	38.4	12.0
1970	41.1	24.1	31.5	3.3
NZ				
1956	25.6	21.7	36.2	16.4
1971	33.7	20.6	34.0	11.6
Australia				
1947	22.7	28.1	31.9	17.2
1971	29.7	30.5	30.7	9.1
Japan				
1960	17.9	18.4	31.3	32.4
1975	29.6	22.7	33.8	13.9

Source: Conway (1981)

European settlers' social policy of 'egalitarianism' has resulted in an extensive telecommunications infrastructure which now serves the country well, as can be seen from the following table.

Table 3. TELEPHONES, RADIOS AND TELEVISION SETS PER 1000 HEAD OF POPULATION IN 5 PACIFIC BASIN COUNTRIES

No. per 1000	NZ	USA	Canada	Australia	Japan
Telephones (1978)	545	744	632	415	422
Radios (1976)	865	1822(*)	1011	770	530
Television sets (1976)	259	571(*)	428	351	235(*)

(*) 1975 Figures

Source: 1981 NZ Year Book

At the time of the 1976 census, 89.9 per cent of New Zealand householders had telephones and 67.7 per cent had black and white television sets (colour = 17.3 per cent). The next two tables give increases in the number of TV licences over a 15 year period and the percentage of the population able to receive one (or both) of the two national television channels.

Table 4. NUMBER OF TELEVISION LICENCES ISSUED AT 4 YEARLY INTERVALS BETWEEN 1963 AND 1978

Year	Black & White (000's)	Colour (000's)	
1963	23.3		Start of public TV in 1960
1967	434.9		
1970	627.6		
1974	754.6	12.2	Start of colour TV in 1973
1978	843.6	394.2	

Source: Conway (1981)

Table 5. PERCENTAGE OF POPULATION IN TV RECEPTION AREAS

Year	TV1 (%)	TV2 (%)
1966	89.0	
1971	99.0	
1975	99.9	70.0
1976	99.9	71.8
1977	99.9	77.0
1978	99.95	90.0
1980 (December)	99.95	91.3

Source: Conway (1981)

The high penetration of telecommunication services in New Zealand shows that the country has been able to keep abreast of the demand by the people for telephone, radio and TV services. However, a huge capital and human investment in the telecommunications' infrastructure have made Government planners acutely aware that imported new communications technology is likely to have a profound effect upon the economic and social life of the country. Things have been different in New Zealand telecommunications circles since the early nineteen sixties, when an almost leisurely pace of development and steady rate of change was the 'order-of-the-day'. Now the frenetic pace, and at times confusing array of new communications developments, make "anticipatory" planning a matter of economic and social survival.(3)

What made a difference to Government thinking in sixties was the veritable deluge of concern from

overseas about the new communications technologies and the social implications of telecommunications in general. Gerald Eldin, Deputy Secretary General of OECD, summarised the issue as follows: "Among the indispensable elements of the infrastructure of a modern economy, a telecommunication network incontestably occupies choice of place, and which no government concerned with industrial development can afford to ignore".(4) Later, Mischa Swartz in a guest editorial on the "Social Implications of Telecommunications", had this to say about the explosive developments in communication technology: "There is no question that we are currently witnessing a veritable revolution in the development and use of communication and information technology throughout the world".(5)

While we have always been influenced by overseas trends and developments in telecommunications we have, nevertheless recognised that circumstances in this country differ from those in other countries, and that while we can learn from overseas experiences we have indigenous telecommunication infrastructure and a social and cultural value structure to maintain. Our position is best described in this statement from a recent Task Force report on economic and social planning in New Zealand: "We also need to learn from experience elsewhere, but at the same time remember to reinterpret such experience to bring it to harmony with the situation and scale of New Zealand".(6) Reinterpretation of our national economic experiences in the face of tightening access to overseas markets and the general need to coordinate planning at the national level has underlain developments in the telecommunications sector of the economy in recent years.

3. COORDINATION OF PLANNING AT THE NATIONAL LEVEL

New Zealanders became conscious of the need for national long-term planning in the early 1950's when it became apparent that "in order to achieve a faster, more balanced, economic growth coupled with the proper consideration for environmental, social and other new-material factors a changed attitude regarding the Government's role in growth and development" was necessary.(7) A number of national conferences during the 1950's and 1960's highlighted the importance of long-term planning and indicated that this type of preparation required the formation of 'permanent machinery' to oversee the planning. Furthermore, as each sector of the economy (Agriculture, Forestry, Tourism, etc.) was 'going it alone', the Government took steps, during the latter years of the 1960's, to coordinate economic planning on a national basis by holding a National Development Conference (NDC).

The outcome of NDC was the adoption of national and sector growth targets and a series of recommendations to guide planners. The National Development Council, formed to coordinate sector growth strategies following NDC, was abolished in

due course and its functions taken over by the Cabinet Committee on Policy and Priorities, thus acknowledging that the final responsibility for long term planning ultimately lies with the Government.

Yet by the mid 1970's, there was a general feeling that centralised planning had lost its momentum and revitalisation was needed. In 1976, the Government established a Task Force on social and economic planning "to review past planning activities in New Zealand, to advise on major trends and issues, and to recommend a planning mechanism that would assist in the development of New Zealand's economy and society".(8) The Report of the Task Force, "New Zealand at the Turning Point" (1976), recommended the development of a national planning system.(9)

As a first step in this direction, the Government set up a New Zealand Planning Council in March 1977. The Planning Council was to comprise people of "wide experience in many fields", have a full-time secretariat, and include the Minister of National Development. Its functions and powers included advising the Government on "planning for social, economic, and cultural development in New Zealand", and it was required to act as a focal point for a process of consultative planning about New Zealand's medium term development".(10) After a vigorous and promising start the Planning Council is now to be reduced in size and reorganised ostensibly because of Government cost-cutting and other efficiency measures, but one suspects that its very success was a failure: it presented too many different points-of-view to those of the Government's own chief advisors.

At the same time the Task Force was undertaking its review, another planning body came into existence. Called the "Commission for the Future", it developed out of the National Party's 1975 Election Manifesto which stated that, "a National Government, recognising the need for long-term thinking and planning will establish a Commission for the Future".(11) The Commission, in addition to studying the implications of long-term economic and social development of New Zealand, was charged with the task of stimulating public debate. So well did it adhere to its task, that it gained even more official displeasure than the Planning Council and was ultimately disbanded.(12) & (13)

Nevertheless, one of its last published reports was a forward looking account of "Network New Zealand: Communications in the Future" (1981). Network was an attempt to convey "to the general public the complex technical developments in communication and information and their possible social impacts".(14) After all, the need for long-term planning in telecommunications was as important to the country as in other sectors of social and economic life. The Commission

realised this, but their 30 years Futures scenarios seemed too fantastic for pragmatic politicians and government officials.(15) Thus, a unique experiment in Futures work came to an end in May 1982 and the Commission's long-term planning role has now gone to the new Planning Council. Fortunately, long-term planning in telecommunications is already the responsibility of another advisory body; the Communications Advisory Council.

4. COORDINATION OF TELECOMMUNICATIONS DEVELOPMENT AND POLICY(16)

Except for a brief period during the early days of telegraphy and broadcasting respectively, the Central Government has assumed the responsibility for providing, operating, and maintaining public telecommunications services in New Zealand.(17) The two principal governmental agencies authorised to provide this service are the Post Office and the Broadcasting Corporation. Neither body exercises any formal control in a planning or developmental sense because, as shown later in the case studies, this is really the function of Government which acts, in telecommunications matters, on the advice of the Postmaster-General, the Minister of Broadcasting, and the Cabinet Committee dealing with communications issues and policy.

The first attempts to coordinate the development of a national telecommunications network were made in 1947 with the establishment of an inter-departmental committee known as the Civil Communications Committee. This committee was the result of increasing conflict among Government departments over the provision of 'private' communication services (mainly radio services) in the post-World War II period.(18) Two subcommittees were also formed: (1) Frequency Advisory; and (2) Projects. Although moderately active in the early years, because of later disuse "none of the committees had any significant impact on the policymaking process".(19)

Why the Civil Communications Committee, in practice, was largely ineffective can be inferred from the attitude of the Post Office towards the whole matter of coordination. It reported to the 1977 Communications Commission that: "The Post Office believes it is in the forefront of New Zealand organisations in the matter of expertise and experience in the telecommunications art. This implies a responsibility for the overall coordination of telecommunications development to ensure that resources are used to the best advantage and that there is optimum system and equipment compatibility".(20) But bearing in mind that the Post Office chaired all three committees and was responsible for both calling meetings and circulating minutes, it is easy to see that it had no intention of giving up any of its development and policymaking influence to any other group. As far as the Post Office was concerned the Government itself, operating through Cabinet and its committees, had the ultimate

coordinating role, but if it needed technical advice, then the Post Office was best placed to give it.

4.1 THE COMMUNICATIONS ADVISORY COUNCIL

It was recognised by the present Government when in opposition (1973-75) that "a clearly articulated and widely debated telecommunications policy"(21) was needed and when it returned to the Treasury benches it set up a Communications Commission in June 1976 "to survey the evolution, present use and existing forward planning of telecommunications as affecting New Zealand".(22) The Commission, in its review of attempts to coordinate telecommunications development and the fragmentation of development over the years, expressed the view that "experiences with previous efforts in coordination reveal a trend which requires arresting", and proposed the establishment of a structured permanent coordinating body designed to overcome the type of problems encountered by the Civil Communications Committee.(23)

Following the Report of the Commission, the Government established a Communications Advisory Council as an advisory body to, among other things, "Formulate, coordinate, review and recommend longer term national telecommunications policies and monitor their implementation".(24) The Council, which has a small permanent secretariate, draws its membership from Government, private and tertiary education sectors and the Planning Council.

5. GROUPS AND ORGANISATIONS PROVIDING AND USING TELECOMMUNICATIONS SERVICES

The major providers of telecommunications services are two government organisations: the Broadcasting Corporation of New Zealand (Broadcasting) and the New Zealand Post Office (Post Office). Both are virtual monopolies with the Post Office providing public telecommunications services (excepting broadcasting services) and Broadcasting providing sound radio and television services. In both cases there are exceptions to the 'common carrier' rule with some private telecommunications networks, where the Post Office has been unable to provide the type of service required (i.e. New Zealand Electricity Department, Civil Aviation Division of the Ministry of Transport, New Zealand Railways, and Land Mobile Users Associations), and a small number of 'licenced' private sound broadcasting stations.

5.1 THE POST OFFICE

The New Zealand Post Office derives its authority from the Post Office Act 1959 and is directly responsible to the Postmaster General, a Minister of the Crown. It is responsible, among other things, for improving "... the availability, diversity and efficiency of telecommunications services, to widen the range of services available

and to improve response times to the provision of service".(25) In addition the Post Office is authorised to regulate the radio frequency spectrum. To undertake its mission the Post Office had a telecommunications service budget of \$550,373,000 and a staff strength of 24,946 in 1982.(26)

The Post Office takes an active interest in international organisations such as ITU, INTELSAT, INMARSAT, the Commonwealth Telecommunication Organisation, COMFAC, SEACOM, and TASMAN. In accordance with the technical standards agreed to at the meetings of these organisations it usually makes its own decisions about the supply of equipment and the introduction, or upgrading, of present services. Such independence in planning and development has lead some commentators to observe that "In many vital regards New Zealand's telecommunications policy is circumscribed by developments overseas".(27)

5.2 BROADCASTING CORPORATION

Since 1931 Broadcasting in New Zealand has been under public control, although there are a small number of privately owned radio stations and some use made of the public television network by private enterprise. The four major Broadcasting Acts have reflected recent changes in Government, with the National Party tending to favour some form of private enterprise and the Labour Party maintaining a strong belief in public control of Broadcasting. The organisational "see-sawing" that has affected Broadcasting over the years is well documented in Stewart and Moss.(28) Suffice it to say, that the latest Broadcasting Act (1976) transferred control back to one central corporation and later to avoid wasteful duplication, a further reorganisation of television services (TV 1 and TV 2) in 1980, saw a unified two-channel operation offering complementary programmes.

The Broadcasting Corporation, like the Post Office is a financially self-supporting Government Department with a budget of \$155,000,000(29) and a staff strength of 3,500 in 1982(30) and is responsible, through the Minister of Broadcasting, with the mission "to carry on public broadcasting services and to develop, extend and improve them in the public interest. In doing so it must have regard for the general broadcasting policy of the Government. The Minister may direct the Corporation in writing (although not on specific programme matters or complaints) but any such direction must subsequently be 'gazetted' and laid before Parliament".(31)

5.3 THE USERS

It goes almost without saying that the users of telecommunications services in New Zealand are from nearly every sector of society, from private citizens with telephones to Government and business operations requiring additional services such as telex, radio, facsimile and data networks. The impact of telecommunications on New Zealand

society is all pervasive ranking in importance with "other essential services, such as energy and transport".(32) The high demand for basic telecommunications services and new techniques in data communications account for the reason why this country considers telecommunications services for business and pleasure essential services.

5.4 SPECIAL INTEREST GROUPS

Surprisingly though, the quantity of telecommunication equipment manufactured in New Zealand (apart from domestic radios and television receivers) has been rather small. There is good reason for this according to the Post Office: "The specialist nature of much of the equipment in the small market in New Zealand has meant that the major providers of telecommunications services - Post Office and Broadcasting - rely heavily on imported products".(33) The Post Office estimated that in 1975/76 the proportion of locally made equipment it purchased was about 25 per cent to Broadcasting's 8 per cent.(34)

5.5 GOVERNMENT DEPARTMENTS

In the present economic climate it has become increasingly difficult for the heavy users of telecommunications services (mostly Government departments) to get the necessary overseas funds. The Government department that plays a major role in the allocation of the VOTE (Government expenditure) each year is the Treasury. As an independent advisor to the Cabinet on public expenditure, the Treasury not only can influence the timing of telecommunications development, but it also can have a direct influence on new policy issues as is indicated in the case studies below.

The Treasury is not the only Government department that has a big impact upon the amount and type of communication equipment imported into New Zealand. Because funds for overseas purchases are limited, and pressure over the past decade has been mounting within the country to increase the local content of telecommunications equipment, the Department of Trade and Industry has the job of administering import controls and stimulating local industry. Its power is directly proportional to the amount of conflict generated by inter-stated parties when overseas funds are concerned.

6. THE POLICYMAKING PROCESS IN NEW ZEALAND TELECOMMUNICATIONS 1960-78

6.1 PRIMARY INPUTS

The policymaking process in New Zealand telecommunications during a period spanning almost two decades has been well documented by Zwimpfer.(35) Suffice it to say that he uses McCurdy's policy-analysis model(36) to clarify the role of policymaking in the total political system drawing special attention to the demands by people who create the 'primary inputs' to public policymaking. People's demands finds

expression through (1) private individuals, (2) pressure groups, and (3) political parties.

6.2 SECONDARY INPUTS

In addition to these primary inputs to public policymaking there are also secondary inputs. These are: (1) Election manifesto (prepared by a political party to outline its mission); (2) Parliament (the source of governmental power and a debating forum to publicise issues and criticise Government performance); (3) Caucus (the parliamentary group of the governing party); (4) The Prime Minister (the most powerful single figure in the public policymaking process); (5) Cabinet (the body governing the country and responsible for making policy decisions based upon an election manifesto); (6) Ministers of the Crown (Cabinet Ministers with statutory responsibilities for leading Government Departments); (7) Department Administrators (Public Service advisors to their Minister on policy and also the implementors of public policy decisions); (8) Departmental Experts (people with special knowledge or skills who advise Department Heads, especially on technical matters to do with their field of competence); (9) Ombudsman (an arbitrator with special authority to investigate individual citizen's complaints of the Public Service); (10) Referendum (referenda, although not often used, can resolve public issues of great moment); (11) The Media (radio, television and the newspapers provide a public forum in which to discuss current issues and generate debates).

6.3 ENVIRONMENTAL INPUTS

It would be naive to believe that people are the sole progenitors of public policy. There are environmental inputs which must also be taken into account. Two important ones are: (1) International pressures (New Zealand's heavy dependence upon overseas trade, its policy of importing appropriate telecommunications technology, and its collaboration with international organisations involved in establishing world standards and services has made it susceptible to, and dependent upon, other countries' actions and influences). (2) National Economy (the rapid nature of technological change and the fluid nature of society has the national economy in a "state of turbulence" making accurate economic forecasts, even up to 12 months ahead, a hazardous task).

6.4 MINISTER-DEPARTMENTAL HEAD RELATIONSHIP

Although policy and administration are thought of as two distinct domains (with the Government making policy and the Departmental Head then implementing that policy), in practice the Minister responsible for a Department and its permanent Head work jointly on policy formulation.

6.5 THE EXPERT/ADVISER

Policy issues involving technological change

create a special set of problems because the contribution of the 'expert' takes on greater importance than usual, and the opportunity by the public to participate in decisionmaking is inevitably limited. Thus departmental 'experts' not only give advice to policymakers (the Government), but because of the technical nature of their Department's work, also inevitably end up as the administrators of this policy and therefore bring direct influence to bear on policy-making decisions.

In summary, public policymaking in telecommunications in New Zealand has three main components: (1) the potential contributors; (2) the Minister/Head of Department relationship; and (3) what Zwimpfer refers to as "special problems associated with policymaking for technological change". (37) To better understand how these components interact in New Zealand telecommunications, two short case studies will be used.

7. THE CASE STUDIES

Research into policymaking processes in New Zealand government departments is rare mainly because the Official Secrets Act severely restricts the use of Departmental information outside the Public Service. (38) Nevertheless, there is some policy research available, and one study in particular gives a revealing insight into telecommunications policymaking processes using a series of case studies to show how policy decisions are arrived at. (39) Because of the lack of space only two cases can be reported here. Both cases however show the Post Office in its traditional role of 'common carrier' and illustrate how internal and external influences affect the development of telecommunications services in New Zealand.

7.1 CASE STUDY (1): INTRODUCTION OF TELEPHONE FREE-CALLING BETWEEN PAKAPURA/MANUREWA AND AUCKLAND

7.1.1 BACKGROUND

New Zealand has always had a system of changing a basic fixed annual rental giving unlimited local telephone calling at no additional charge. Although the 'base rate' area was within one mile of an exchange up to 1923, in subsequent years the toll-free calling areas grew in size and it was envisaged by one Director-General of the Post Office that eventually all 'short-haul calls' would be toll-free. The burgeoning "user" growth of Pakapura/Manurewa districts (dormitory and industrial areas of Auckland - New Zealand's largest city) indicated that there would be agitation for the extension of the Auckland free-calling area to include these districts.

7.1.2 POLICY INITIATION

Pressure mainly from businessmen in the Manurewa area in the early 1960's, prompted the Post Office to undertake a study to confirm demand for

'free-calling'. A technical report by the Post Office Engineering Branch indicated that expansion was feasible and the Postmaster-General approved the move to bring Manurewa/Papakura into the Auckland free-calling area by 1969, even though this was an exception to the established policy of charging tolls between toll groups. The actual time of the changeover was not fixed and this proved to be the critical policy decision, dependent primarily on the state of the New Zealand economy.

7.1.3. THE PARTICIPANTS

The list of major inputs in this case study is long, involving as it did the following: (1) Pressure groups (mainly business and local government groups); (2) Ministers (there were seven separate Ministers involved between 1964 and 1978); (3) Members of Parliament (members for Manukau and Manurewa were involved); (4) Post Office Administrators (there were four different Directors-General during the period); (5) Post Office Experts (a large number were consulted or involved in the planning and implementation phases); (6) Parliamentary Petitions Committee and Ombudsman (both bodies were involved when local residents of Manurewa/Papakura petitioned); (7) Environmental Inputs (the availability of overseas funds for the purchase of equipment at a time when New Zealand's economy was under pressure made this a critical factor in delaying the crossover).

7.1.4 THE POLICYMAKING PROCESSES

Soon after the decision to provide free-calling had been made in 1964, the Post Office engineers proceeded with the implementation phase. Free-calling in the Pakapura/Manurewa area was scheduled for 1969. Nevertheless, there were other competing priorities in the view of the Post Office, such as the provision of services for subscribers without any at all, and the extension of services for those on restricted services.

Public pressure caused a Minister to raise the question of timing for the introduction of free-calling in Parliament, in 1967, and he was told by the Postmaster-General (on the advice of the Director-General of the Post Office) that, subject to finance, 1970 was now the likely starting date. The very next year the Post Office reassessed its plans but this time suggesting the mid-1970's, because of the lead time required to call for tenders and to instal the necessary "new type of telephone exchange switching" equipment now needed for the Auckland network.

Meanwhile pressure mounted again and in March 1971 a deputation of businessmen and civic leaders from Pakapura/Manurewa met the Postmaster-General to express their concern about the delay, but they were told at a meeting that other more pressing demands made a date earlier than 1975 impossible to achieve. Next year there was a

change in government and the local member for Manurewa, Hon. Mr Douglas was appointed Postmaster-General. Even so he was unable to 'speed up' the long 'lead time' required for the tendering and purchase of new cross-bar equipment even though the Post Office was given authority to increase its forward planning costings for telecommunications development over the next five years due to favourable international monetary exchange rates at that time.

Escalating costs of the move to free-calling (now estimated to be \$4.4 million), and a scarcity of manpower resources led to a further delay in development. In early 1974 the Post Office announced that the introduction of free-calling would be introduced to coincide with the issue of the September 1976 Auckland Telephone Directory and placed orders for the technical equipment. However, financial problems were pending. In spite of the previous optimism, finance available for developments in telecommunications were less than planned for in 1974 and further capital works were delayed when it was also realised that manpower planning figures for the project underestimated what would be required.

Late in 1975, another General Election saw a change in government and the new Member for Manurewa, the Hon. Mr Wellington, joined the government benches. (To save him from a kind of embarrassment he was not appointed Postmaster-General, but became instead the Minister of Education).

Public pressure mounted during 1976 with MP's, newspapers, and civic deputations all voicing opposition to further delays. The new Postmaster-General, the Hon. Mr Templeton, armed with briefing papers from the Post Office declared that a new crossover date of early 1978 had now been set, because, he said, the equipment had only just 'come to hand' and it would take at least two years to install it.

Even so another attempt was made to bring this date forward. A petition of 5089 signatures was taken to the Petitions Committee of Parliament in August 1974 requesting that Parliament reconsider the recently announced decision on free-calling in Papakura/Manurewa. The petition was also referred to the Ombudsman who reported that the long history of delays was "largely beyond the Department's control" as the availability of resources for this kind of work had steadily deteriorated over the years. The Ombudsman's view was referred back to the organiser of the petition. No change being made in the change-over date which eventually was April 1978.

7.2 CASE STUDY (2): ESTABLISHMENT OF A SATELLITE EARTH STATION IN NEW ZEALAND

7.2.1 BACKGROUND

The Post Office has the responsibility for operating and developing overseas telecommunications

services. New Zealand is a member of the Commonwealth Cable Management Committee (COMPAC and SWACOM) and one of the countries responsible for the management and operation of these submarine telephone cable systems. In the mid 1960's it was estimated by the Post Office that the trans-Tasman COMPAC cable would reach full capacity by 1969. There were only two options for the provision of further capacity: (1) an additional trans-Tasman submarine cable; and (2) a satellite earth station in New Zealand linked into ITELSAT.

7.2.2 THE POLICY ISSUE

The policy issue concerned a choice between cable or satellite. Cables were a proven technology while communications satellites were new. Nevertheless, the use of satellites for communication purposes was rapidly expanding at the time and they had the persuasive advantage of being able to relay 'live' colour television from overseas. Furthermore, New Zealand had been a signatory to an International Agreement on interim arrangements for a global communication satellite (INTELSAT) in 1965. Whatever the final decision, each option involved major capital expenditure, a requirement which would involve both Treasury and Cabinet.

7.2.3 POLICY INITIATION

The Post Office initiated a policy proposal based upon data about present use and future projections of traffic requirements.

7.2.4 PARTICIPANTS

Participants both within New Zealand and outside the country would be involved in the policy decision. They were: (1) Government Departments (Post Office, Broadcasting, Civil Aviation, External Affairs, Defence and Treasury); (2) Postmaster-General; (3) Ministers (of associated departments); (4) Cabinet (for final decision); (5) International partner (in this case the Australian Overseas Telecommunications Administration - OTC).

7.2.5 POLICYMAKING PROCESSES

As early as June 1966 Post Office engineers reported that "it would take 3-4 years to design, install and commission an earth station, after a firm policy decision had been made". Because of the urgency surrounding a choice between satellite or cable the Director-General of the Post Office commissioned reports "comparing the advantages and disadvantages of the satellite and cable alternatives", which on balance indicated a preference for cable even though it was recognised that "television considerations" and a "slightly higher financial return" could swing the balance in favour of the satellite. Other government departments were advised of the Post Office preference for cable, and, surprisingly, "Broadcasting showed no marked preference for one alternative".

Moves were made to seek Cabinet's approval to contact Australia, but before this could be actioned the General Manager of OTC advised the Post Office that Australia preferred satellite development at that time rather than a second trans-Tasman cable. Subsequent discussion with the Australians in September 1967 resulted in an agreement being reached "that while both satellite and additional cable capacity would eventually be required, satellite development should come first".

The Cabinet Economic Committee consulted the Post Office and OTC officials then agreed in principle with the satellite option. Other government departments were in agreement including Treasury who "considered the proposal justified if a satisfactory service was to be maintained". In April 1968, Cabinet gave its approval for the establishment of a satellite earth station, which eventually opened at Warkworth in July 1971.

8. ANALYSIS OF THE CASE STUDIES

The two case studies both involved technological change (Case 1 - telephone exchange equipment and Case 2 - satellite earth station). Similarly they involved public demand (present and future) for better services. In each case the public demand was monitored by the Post Office. In both cases, technical departmental experts played an important role in initiating the policy decisions.

The dominant influence in the policymaking process in the case studies was the Post Office, although it was not the 'focus of power' in the final policy decisions. Similarly, the main role of the Ministers and Cabinet was to make policy decisions, but in fact they "had little net impact upon final policy decisions".(40) Other government departments had considerable input, as Treasury did in both cases. Non-governmental pressure groups, mentioned in Case 1, did not have much influence upon the policy decision, but there are other instances where they have been successful in influencing the Post Office and the policymaking process.(41)

The formal policy decisions in the case studies were eventually taken at Ministerial or Cabinet level mainly because the issues could not be resolved by the Post Office alone. There are again cases (not reported here) where the Post Office (or Broadcasting) has dealt with policy issues at the administrative level.(42) In the cases studied here advice on the implementation of policy was provided by the Post Office. In Case 2 the policy decision was really outside the control of the government because, when Australia would not join New Zealand in providing a new cable, then a satellite earth station remained the only choice.

There are some interesting common trends in the case studies. An analysis of the policymaking

processes demonstrates that the Post Office believed they were "best equipped to make the policy decision", after which the Minister "ratified" (where necessary) the decisions before the bureaucracy proceeded to implement the policy. Usually, policy decisions in telecommunications are made at the administrative level after consultation with interested parties if the Post Office (or Broadcasting for that matter) thinks this necessary.

When it comes to considering which of the inputs mentioned above attained primacy in New Zealand telecommunications policymaking certain points stand out. It is interesting to note, for instance, that in both cases the Post Office was not the real "focus of power". In Case 1 the power lay with Treasury and the Government through the allocation of financial resources, and in Case 2 the power lay with OTC (Australia). Although there are occasions when the Post Office is the "focus of power" in policymaking(42) in most instances "... despite popular opinion to the contrary, the power of the bureaucracy in technological issues may not be as great as it is often given credit (or blame) for".(43) Be that as it may a general 'freeing up' of information would help improve the 'image' of government departments and dispel some of the popular myths about the work of bureaucrats.

Do government departments always work in the public's best interests? It's hard to know because of the Official Secrets Act. One would expect that each department interpreted its actions in terms of what is best for the public, and the same could be said of the motives of special interest groups. The case studies suggest that each Government department "... represents particular aspects of the public interest" and that resolution of policy conflicts when they arise come from knowing the contributions and needs of all sides. It's only when all inputs are combined that the true public interest can be served.

Case 1 indicated that the present policymaking machinery in the Government is slow to respond to change (Case 1 = 14 years) and is "consistent with the character of bureaucratic organisations which cope well in times of stability but tend to be unresponsive to change".(44) This is even more reason for long term policy planning in telecommunications, and the motive behind setting up the Communications Advisory Council.

Some critics of state-run monopolies have taken issue with the fact that bureaucracies initiate new policy when it is the Government's role to make policy and the bureaucrat's place to implement it. While the line between existing policy and new policy is a fine one, in practice any expenditure above a certain figure automatically requires Cabinet approval so that the Minister, in effect, plays a key role in overseeing policy initiation by government departments. In fact, Case 2 demonstrated the need for

the Post Office to initiate policy so as to ameliorate the social impact of increased congestion in future international communications. "Clearly then, inaction can have an impact equally important to action".(45) On the other hand there are instances of the Post Office making unilateral decisions on policy matters without due consultation, as it did over the VHF Maritime Radio issue (see also Broadcasting actions over its own microwave links).(46) Nevertheless, even these decisions eventually had to come before Cabinet for ratification, although the delay and cost may have been considerable.

There is no doubt that technical experts had a big input into the way that policy decisions were made in the case studies. Furthermore, it is well known that senior administrators in key posts in the Post Office during the period under study were trained as professional engineers. That being so, there is no evidence that Post Office experts and administrators were especially unskilled in dealing with policy issues; "Engineers can be effective in administration, but it does not necessarily follow that all engineers make good administrators".(47) That being so there is Public concern that a relatively small group from the Post Office and Broadcasting are making decisions about new communications technology.(48) With so much at stake wider consultation would appear a sensible practice in telecommunications developments.

Finally, in the past it was not common practice for the public to participate in policymaking processes in telecommunications. The Case Studies show that the public was involved in Case 1. In Case 1 they attempted to make their views known through pressure group actions. In Case 2 at the time the policy decisions were being made, the public took the move much for granted. It's interesting to speculate on whether they would react the same way today about satellite earth stations now that new developments in communications technology have become a subject of much public debate.

9. CONCLUSION

Planning for the future has been an important issue in New Zealand over the last two decades. This paper indicates that central government has taken steps to set up the necessary planning machinery to advise it on economic and social policy. In line with this move the Communications Advisory Council has been established to help the government coordinate, formulate, review and recommend longer term national telecommunications policies. If it does what it's required to do then New Zealand may soon have a coherent national communications policy.

The Case Studies demonstrated the complexity of policymaking processes in telecommunications. They showed that "policy formulation, adaptation and change has had to be an interactive process. An ad hoc a day has kept policies

in play".(49) That approach is now obsolete if we want to keep up with other industrialised Pacific neighbours. What we don't yet have, and what we need, is a national communications policy.

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- (25) Annual Estimates of Expenditure, (1982).
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- (32) Communications Commission, op.cit., p.110.
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- (34) Communications Commission, op.cit., p.122.
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- (41) Ibid, pp.103-121.
- (42) Ibid, pp.122-126.
- (43) Ibid, pp.151-152.
- (44) Ibid, p.152.
- (45) Ibid, p.153.
- (46) Ibid, pp.85-102.
- (47) Ibid, p.154.
- (48) Stewart and Moss, op.cit., p.69.
- (49) Ibid, p.70.

FORMULATING A COMMUNICATIONS STRATEGY

IAN G. DEWIS
B.L. SYSTEMS LIMITED
REDDITCH, U.K.

BLSL has recently adopted an "Information Communication Strategy" which, together with "Data" and "Processing" strategies, forms the basis of an "Information Utility" to meet the business needs of its customers. The strategy covers all types of information that need to be transmitted between BLSL and its customers' sites, including data, text, image and speech. It is assumed that the current use of analogue transmission will continue for a number of years until it is replaced by digital transmission. The strategy addresses the issue of communication standards by adopting the use of ISO "Open Systems Interconnection" recommendations as appropriate ones become available.

1. INTRODUCTION

Mechanical switching systems and analogue transmission techniques are being replaced by digital switching and transmission. These will be achieved by British Telecom (BT), for example, through its System X family of advanced software-controlled systems and its X-stream services. It is estimated that optical-fibre digital systems will account for half the BT transmission network trunk capacity by 1990.

Equipment manufacturers in the Information Technology (IT) industry are also taking great strides forward, but not always in the same direction. There has been very little natural compatibility between manufacturers except where one or two standards exist or where some manufacturers have decided to exploit a large market created by another.

Companies should not be tempted to exploit technology for technology's sake, but should use it only where it can be seen to support their business needs. Examples of such a temptation are all too clearly seen in the area of office systems, where many companies are currently installing individual modules which do not form a consistent whole.

2. INFORMATION COMMUNICATION

BLSL's information communication strategy is one of its IT strategies, but what exactly is 'information communication'? 'Information' is a global phrase used to encompass a wide range of traffic types including data (i.e. structured format), text (unstructured), image and speech. 'Communication' is composed of two parts - interlinking and interworking.

Interlinking is the transport of information from the output of a source device to the input of a destination device whereas interworking is the mutually intelligible dialogue that takes place between the two parties so connected.

Communication in the information systems context is made up of three stages. First, there is the simple medium (usually electrical) used to transmit signals. This will usually be twisted pairs, coaxial cables, microwave radio channels, fibre optics or a combination of these. BLSL employs BT circuits, coaxial inplant cabling (as used in the Land Rover factory) and its own microwave system which gives access to over 50 sites.

Once the connection medium is available, there is a need for standards to enable simple electrical linking of the termination devices to be implemented. This is the second interlinking stage. Thirdly, when devices are connected and interlinked, it is necessary for them to be able to communicate in a meaningful way. This is the third interworking stage.

3. STANDARDS

As has been stated earlier, the problem in the information systems world is that interlinking and interworking standards tend to be set by manufacturers to cover their own products. Some standards exist on interlinking but standards for interworking are virtually non-existent. This problem is being addressed internationally through various standards organisations and the BLSL strategy

follows the route being established by the International Standards Organisation (ISO) with its Open Systems Interconnection (OSI) recommendations.

4. BLSL

BLSL is a wholly-owned subsidiary of BL plc. It offers systems and communication services to the parent company which is its major customer, although it is looking to expand its external customer base. The company operates a large communication and data centre in Redditch, Worcestershire, comprising mainly IBM and IBM-compatible equipment. Computers are also used widely in the area of production and process control at plant level where equipment mainly from Digital Equipment Corporation (DEC) is used. Equipment compatible with the communication standards set by IBM and DEC represents about 90% of the installed base of information systems equipment within the company and provided users follow the BLSL procurement policy, this situation will continue and it is this that the strategy is designed to cope with.

BLSL's information communication strategy has been developed by its Advanced Systems Department - a research and development function within the company with the brief to develop and maintain strategies in key areas, to evaluate new technologies and methods and to back these with pilot projects where necessary. In asking the Advanced Systems Department to develop and implement the strategy, the company recognised the need and importance of such a strategy and has already derived benefits from its existence.

5. PIVOTAL STRATEGIES

The IT strategies of BLSL focus on three key or pivotal strategies: data, processing and communication. Communication is sometimes believed to be the dependent variable but it is much more than this - it is an opportunity. A company that gets its communication strategy right will find that it can do much more with data and processing. Communication is the 'glue' which will hold future systems together and it is therefore imperative that all aspects of communication are given the attention they merit.

As Fig. 1 shows, these three key strategies in turn lead to other strategies. Technical strategies are the more detailed statements of the relevant key strategies. Supportive strategies enable the company to enact the key strategies and these include procurement, productivity and training.

As far as the user is concerned, these strategies combine to produce what is seen by him as being the most important set of strategies - application strategies - which include factory, office, engineering and administration strategies.

Developments within BLSL's information communication strategy are divided into two phases: phase one, where analogue transmission will continue to be used until some time in the 1990s and phase two, where digital techniques will be exploited, (Fig. 2). It is expected that this second phase will commence in about 1984 and that digital transmission will be adopted increasingly as its use becomes more cost effective. The two phases will overlap for several years, ensuring a smooth conversion from analogue to digital working.

At BLSL, the key activities for development within the two elements of interlinking and interworking are given below. As a guide, interlinking equates generally to levels 1, 2 and 3 of the ISO 'Open Systems Interconnection' model and interworking to level 4-7.

6. PHASE ONE - INTERLINKING

The aims of the phase one interlinking programme are

- . to remain analogue
- . to make better use of existing facilities, having a period of consolidation to maximise the use of existing resources
- . no integration of speech and non-speech (i.e. data, text and image) traffic
- . minimal integration of non-speech traffic
- . to gradually adopt OSI interlinking protocols in place of proprietary ones.

7. PHASE ONE - INTERWORKING

The aims of the phase one interworking programme are

- . to gradually adopt OSI interworking protocols in place of proprietary ones
- . a three-stage approach to be adopted achieve this (see Fig. 3).

Stage one, which will last until the end of 1982/middle of 1983, will use existing IBM protocols to link the three generic types of system - IBM, DEC and α , where α is the to-be-appointed 'office systems' supplier.

Stage two, from about 1983 to 1986, will still exploit IBM protocols from IBM to DEC and from IBM to α , but will gradually introduce OSI protocol between DEC and α .

Stage three, from about 1986 onwards, will gradually replace all proprietary communication protocols with their OSI equivalents.

8. PHASE TWO - INTERLINKING

The aims of the phase two interlinking programme (see Fig. 4) are as follows:

- . gradually migrate from analogue to digital transmission
- . develop a wide-area digital network to offer a cost-effective intersite facility
- . develop local-area networks at selected sites to provide cost-effective intrasite facilities
- . provide service networks on top of the digital network which each user or application will see, such that the basic digital infrastructure is hidden.

9. PHASE TWO - INTERWORKING

The objectives of the phase two interworking programme are as follows:

- . applications to use the most appropriate service network
- . a continuation of implementation of OSI interworking protocols

emphasis placed on supporting internal users when accessing external services and on external users accessing BLSL's services via gateway devices.

Phase one concentrates on efficient interworking utilising existing communication facilities, whereas phase two is a gradual move towards digital transmission and the adoption of OSI protocols, providing a smooth introduction of new communication techniques.

Additional technical strategies need to be developed in order to enhance and enact the information communication strategy and those areas that are currently being investigated include IBM's System Network Architecture (SNA), local area networking (LAN), wide area networking (WAN), exploitation of digital microwave and satellite capacity, speech, facsimile and teleconferencing.

10. OPEN SYSTEMS INTERCONNECTION

In the strategy outlined in this article, strong emphasis has been placed on OSI protocols. BLSL's strategic direction is that all applicable OSI protocols will be adopted, both for interlinking and interworking. As a deliberate policy, however, BLSL will not develop its own OSI protocol software packages - it will only take them from suppliers as they are offered and are fully supported. In reality, the information communication strategy may never be fully achieved if complete OSI protocol software is not made available; nevertheless, any in-roads made in this area will be tremendously beneficial. Whereas IBM and DEC equipment currently forms the mainstay of the procurement strategy, once OSI standards are achieved it will open up the way to bring in equipment from other manufacturers much more easily.

In those areas where OSI interfacing software does not become available, it is likely that low-cost microprocessors will be used as emulation and translation devices.

11. CONCLUSIONS

A strategy can never be a statement of fact - it is a signpost pointing the direction towards a recommended destination which may be many years away. The installation of systems which form part of a strategy and which will only 'come together' in the future can cause problems for systems implementors who want to use today's proven technology and install something that they know works now. It is obvious that a strategy cannot dictate the precise timescales and detailed tactical steps required to achieve the end point - these must be determined on an 'as and when' basis.

A strategy may never be accomplished totally. Views may be modified based on two factors - changing technology resulting in new or more cost effective facilities, and changing end-user requirements which can be affected by user awareness of systems capabilities. Either of these could render parts of the strategy inapplicable. Consequently, BLSL believes that its key strategies may need to be refined every 2 or 3 years.

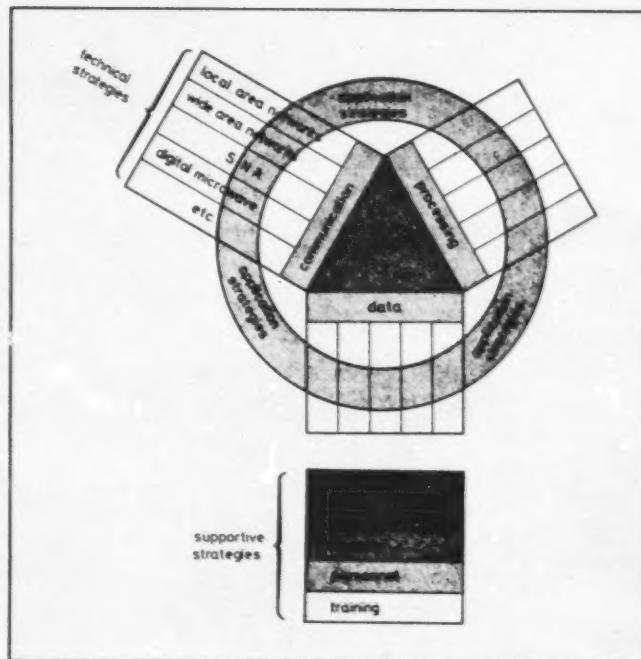


Figure 1 - BLSL's information technology strategies

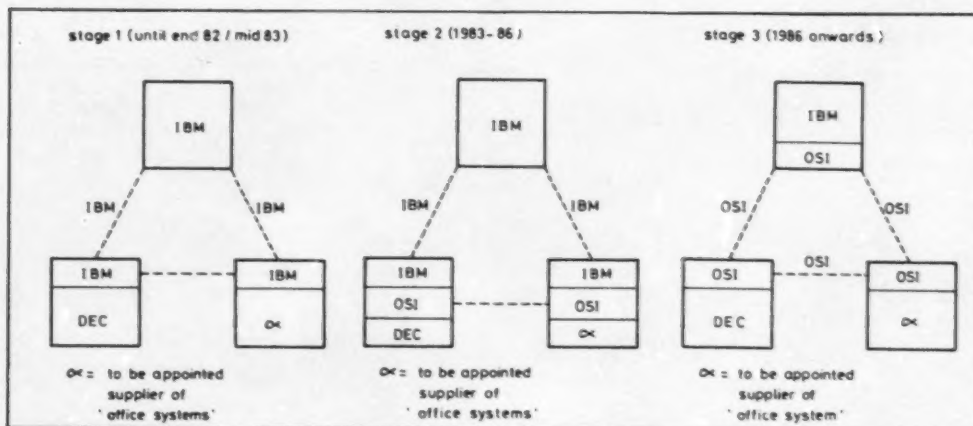


Figure 2 - Three stage approach to adoption of Open-System-Interconnection (OSI protocols)

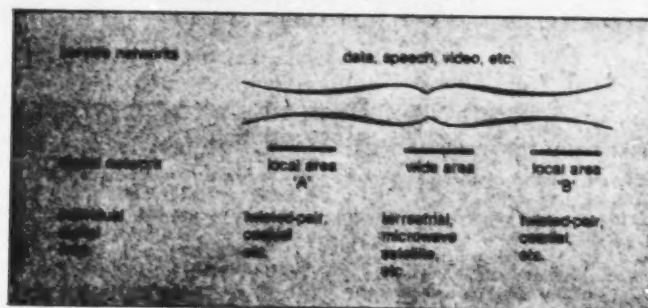


Figure 3 - Hierarchy of digital network layers and connected services

Edward Lohse
Burroughs Corporation
Radnor, Pennsylvania

Abstract

New user needs (universal access to communications facilities), new Data Processing Systems and equipments (Microprocessors and Local Area Network Protocols), new Standardization tools and methods (Reference Model, automation of Standards Management and Text editing), and the current economic climate have combined to force serious consideration to be given to radical changes in the way Standards for Telecommunications and Information Systems are created. This paper describes the problem, and presents a number of steps being addressed toward a solution.

1. INTRODUCTION

International Telecommunication Standards are needed because Common Carriers, each in his own country, must connect to each other, across common national boundaries. In addition, each user of these telecommunications facilities must connect his equipment to a carrier's equipment - usually on his own premises. New international telecommunication standards are needed for several reasons: new technology; more complex, global systems; new applications; and new legal, political, and economic environment.

2. CHANGES AFFECTING STANDARDIZATION

The Telecommunications Industry and in particular the Data Processing Industry, has changed over the past 20 years, driven by advances in electronics leading to many new features of hardware, such as reductions in power and higher computation and switching speeds. The architectural concepts have also improved, and the new memories permit more compact storage of greater volumes of data. The Reference Model is also the cause of some of the changes in the process: it adds a new dimension to the definition of "System"- it is the integration of many levels of system characterization, all to be treated and at least measured, one element against another, in a very complex system. A system which comprises all levels of the Reference Model had not been the subject of any standardization before the availability of the DP of the Model, and the impact is that now we have the ability to define standards for each level, and have work performed on many levels simultaneously. The model says "don't take unilateral action - look at your environment, look at your customer and user, look at the tools you're going to be using. Make sure that you optimize all those interactions as well as considering your own territory".

There are many new applications that yearn for utilization of these new technologies: World Wide Banking, Distributed Data Processing, Security of Split and Shared Data Bases, Duplicated Data Bases, the integration of all functions of an office. All these areas of application put a

demand on both Data Processing and Data Communications. Local Area Networks inside one area, office wiring, PBX's behind PBX's, are aspects of complex functions in a Data Communications System. Dispersed Data Processing Systems now ask for transmission facilities of high bandwidths, high degrees of multiplexing, and long distances (that is, Satellites).

For example, Word Processing is one of those applications, but it is also one of the tools that change the way the Standards are written. Draft Standards, from the time of their initial submission as a contribution, can be kept on a Word Processing System. Corrections, updates, revisions, and incorporation of comments from balloting, can all be worked through the Word Processing System on a live basis. There are today a number of small areas of correspondence between a few Rapporteurs on a communicating word processing or text editing basis. In due course, Word Processing, Data Basing and Publication will all be computer-driven, and available to all participants.

Earlier we went through some of the technological changes. They also serve to break down the separation which once was clean, years ago, between the Communications Industry and the Data Processing Industry. These industries now, in fact, overlap in technology. The Data Base for a telephone directory is no different than the Data Base for Social Security records. Table look-up to find out how to sort and how to file certain information is no different than the determination of a heuristic computer-controlled communication tandem path. As these industries, technologies become more alike, so do their opportunities to handle the same applications. Each makes a bigger and bigger, more vital contribution to the new, expanded application area.

Finally, there are new environments involved. I don't mean new ranges of temperature or mechanical hazards. I mean the home: I mean your boat, or your car or suitcase - your computer is where you are, and if the whole computer isn't there, at least the terminal and the communication link termination is. I also mean

that executives now "operate" a computer; the direct action by professionals and non-professionals; executives and clerks; all accessing the same Data Base with the same computer and with privileges that don't necessarily match rank, really constitute the new environment.

3. HOW HAVE THESE CAUSES AFFECTED THE STANDARDS PROCESS?

First, higher levels of Systems Standards are now recognized to be required. But the work that has gone on in the last five years in ISO/TC97/SC16 (Open Systems Interconnection) on the Reference Model has demonstrated that this work can be profitable today. The relationships of Systems Standards to each other, as well as to Component Standards, is becoming clearer and much progress is being made toward arriving at Standards in these areas.

Second, at each level of the Reference Model there can exist not one but a number of viable, necessary, economically beneficial alternatives to operate in that level; perhaps complimenting, perhaps competing with each other. Some of these "competing" alternatives represent new versions replacing old; others may represent different performance (and cost) levels; still others would involve different specific interpretations. At each other level, these alternatives are transparent in every detail except identification and selection. The correlation of these standardization efforts leads to a much greater liaison, leads to larger committees, larger Drafting Groups and in some cases involves simultaneous changes and adjustments in Standards that are under the responsibility of different Bodies.

Third, we need expertise in "Super System" technology, and in some of the newer technical components. The unique characteristics of satellites and the propagation delays that go with their use, the need for encryption, the need for synchronization in world-wide systems, are just a few of the examples of these classes of new expertise. Now the process with these complications will tend to slow down unless we augment quantity of expertise as well as quality and variety. Combining these elements, we have growth in everything but time, which is reduced. This leads to the probability of restructuring Standards Writing Bodies, about which we will say more later. Since we are covering a broad range of applications, there is additional tendency that some of the users are very sophisticated but others are at "entry level". We have been able to make terminals/subscriber sets for their use that are very simple to use, and that are self-teaching (although not as automatic as we would like). We also have a large number of low resource entities participating in the process. Their ability to contribute the specific expertise, to understand the results being accomplished, and their ability to react in a timely manner, represent potential problems for the overall standardization process as well.

Examples of the Standards Projects that are in process today in three major Sub Committees of ISO/TC97 are given in the Boxes, Figures 1-3. The other activities in ISO and IEC are listed in their Annual Reports, Mementos and Yearbooks cited in the Bibliography. The work of the CCITT is in response to "Questions" approved at the VII Plenary Assembly in Nov. 1980. The questions are listed in the Yellow Book, also cited in the Bibliography.

Fig. 1. Standards in Preparation: TC97/SC6

1. Basic Mode Control Procedures (with enhancements) (IS1745 et al)
2. Fault Isolation Procedures using Test Loop (WP)
3. Interface Connectors and Pin Assignments (IS4902, DIS4903, DIS2593)
4. Functional and Electrical Characteristics of Interface connections (WP)
5. X.25 Packet Level DIS7776
6. HDLC: Elements, Classes of Procedure & Frame Structure DIS7777, DIS4339, DIS7809, IS3309
7. Multi link Procedures DIS7478
8. LAN Logical Link Control and Medium Access (WP)
9. Signal Quality DIS7480
10. DTE/DTE Connections DIS7477
11. OSI Physical, Data Link, and Network Services (WP)
12. OSI Aspects of the ISDN (NWI)

CODE

IS = International Standard
NWI = New Work Item
WP = Working Paper
DP = Draft Proposal
DRS = Revision to IS
DIS = Draft International Standard

Fig. 2. Standards in Preparation: TC97/SC18

1. Basic System Functions
2. Text Imaging
3. Text Positioning
4. Coding Requirements
5. Message-Oriented Text Interchange (MOTI) Service Specifications
6. MOTI: Protocol Specifications
7. Reference Model for Text Preparation and Interchange
8. Generic Document Architecture (GDA)
9. Text-Image Format (TIF)
10. Text-Positioning Format (TPF)

Note: As of 1982 Nov. 01, these topics are all in the Working Paper (WP) stage; items 2 and 3 are expected to be registered as Draft Proposals (DP) in Spring of 1983.

Fig. 3. Standardr in Preparation TC97/SC16

1. Reference Model DIS7498
"Connectionless" augmentation
(WP) N1194
2. Transport Layer DP8072
"Connectionless" augmentation
(WP) N1163
3. Session Layer DP8073
4. Virtual Terminal (WP) N1222
5. File Transfer Access and Manipulation
(WP) N1190, N1223, N1224
6. Job Transfer and Manipulation (WP)
N1247, N1248
7. Management N1135, N1134, N1133, N1132
8. Presentation (WP) N1161, N919

CODE

IS = International Standard
NWI = New Work Item
WP = Working Paper
DP = Draft Proposal
DRS = Revision to IS
DIS = Draft International Standard

4. WHAT ARE THE RESULTS OF THESE CHANGES?

First of all, there are many, many more contributions. The "paper mill" is staggering in this area of high technology. In the opinion of the Chairman (or President, if you will) of the U.S. National Committee of the IEC, activity within TC97 of ISO alone is probably greater than the entire activity of the IEC, in terms of volume and number of pages of Standards involved. Obviously, somebody must read these larger and more numerous documents, must give them the same careful scrutiny that they would give a shorter document and must do it in a timely fashion.

There are more frequent meetings with larger total attendance and larger delegation sizes. These meetings, amongst the most prolific Committees, now take the position that they should meet annually for about a weeks length of time in the Sub-Committee Plenary plus about a week's time contiguous with meetings of its major, if not all, Working Groups. In addition, each Working Group would meet for 3 to 5 days at about the half-year mark, independently of all other Working Groups. This is in contrast to the average TC which might meet once a year for three days and others meeting only every other year and a few meeting every decade. The output of such larger meetings, more numerous and larger contributions, results in longer and more complex Standards, which of course are the requirements from the driving forces of new applications and new technology. With the larger technical Standard comes a greater need for vocabulary - more careful definition of terms which are also conventional in basic language as well as terms adopted by different groups in the field but utilizing them in different ways. Another aspect of

the more complicated higher level of Systems Standards activity is the need for properly agreed documents which are not Standards, such as Statements of Principle, Outlines of a Standard, conventional Reports, Guidelines and Application Notes.

There are options available to the user to look at alternative choices, the inclusion or elimination of certain features in most of these Standards. Such option lists represent practical agreements between buyer and seller. If there was only one buyer and one seller working together, there would be no problem with such lists. However, in the more complicated systems environment, there must be a means of identifying that you are using specific options or that you are incapable of receiving traffic that must have optional capability.

5. PROBLEMS CREATED BY THE CHANGES

In describing the causes and impacts above, we have alluded to a few potential problem areas. Even though the level of activity is increased, there is still a great and ever increasing demand for more rapid activity and earlier results. Some feel that the time it takes to produce a standard is too long. Yet, the Committee I chair has drawn criticism for a failure to get affirmative votes when voting at the ISO level. In other words, efforts to accelerate the process make the International and National coordination required to wrap up these standards writing operations difficult to achieve.

On the same line of thought, there is increasing need to use the International "draft" as the Master Document - instead of the National Draft - as we used to do. The International draft needs comments, and speed of progression; the National draft needs technical accuracy, unique National options. Better "selling" of a National position is achieved internationally if a Delegation comes to the table with a potential baseline Document rather than a copy of an adopted National Standard. There is no question that the combination of the greater number of performers, the larger resultant documents and the greater divergency of interest leads to a consensus that is more diffuse and longer lead time to go from the approval of a Work Item to the acceptance of a DIS.

Another administrative aspect of these meetings is a need for multi-language operation. There is a growing tendency to conduct meetings in English, more or less exclusively. Though there are three official languages in ISO, (more, of course in the UN and ITU) there is an increasing tendency to waive translation. Legally the interpreter comes and translates; practically, he contributes little but delay. An impartial measure of how needed translation is, comes from a record of document sales in ISO, in English or in French. (Translation into Russian is done by the GOST, not by ISO, or the other dispersed

Secretariats). Not many years ago there was 30% French of total sales; today the ratio is 85% English and 15% French. There may come a day - in only a few years time - that multilingual Sub-Committee - even Technical Committee - meetings will be forgotten: SC and TC meetings will be conducted as Working Group meetings are conducted today. When that occurs, the additional elapsed time for sequential translation will be eliminated.

A major expense at each meeting is document distribution and reproduction. The backlogs in typing and copying, at some points, set the pace of progress. The Secretariat's editing, logging and mailing impacts frequency of meetings and ballot response time. Automation is a necessity.

You'd expect that there would be some question whether products built to these new Standards are feasible. You are right. There is a growing need for a testing program or for provisional Standards: Standards which on paper have been fully agreed and coordinated for which there is little field experience and where the user could be encouraged to participate in some of the testing. However, we must not confuse such proof tests with conformance or certification tests.

6. INTERNATIONAL STANDARDS COOPERATION

There has always been some interaction between several Standardization Bodies, particularly ISO, IEC, and CCITT. In the totality of their program there has not been direct competition, but there have been certain areas of mutual interest and a few cases of overlap. Some notable forms of cooperation have developed as a result of urgent need, but more often than not, except for liaison, cooperation has sometimes given way to deliberate invasion of another Body's territory. The fact that it is deliberate isn't necessarily wrong, but usually it implies a unilateral decision, rather than a mutual decision, to do that.

When ISO was formed, it was expected that the IEC would have become one of its Technical Divisions. I can't give you the reasons (it was before my entry into the business), but it never did happen. Occasionally ISO and IEC have cooperated and exchanged areas of responsibility and eliminated overlapping operations. But not always. They both are non-treaty organizations but there are various differences between them that tend to make them operate differently. I will make the assertion that we cannot, as industry and as users, continue to support the two Organizations. There are unnecessary duplications of top-level Secretariat, Staff, functions and procedures. Should there be a merger, these expenses could be severely reduced or even eliminated. The question is "Who is going to have the courage to make it happen"? Once the broad agreement that it will and must happen is taken, it will be relatively easy to work out the

details. That agreement would have to be forced by the National constituent bodies.

The second level of coordination in this regard is between Treaty and Non-Treaty organizations (eg. between CCITT and ISO). There is certain autonomy that must be protected and kept viable, because of the backgrounds. The degree of cooperation can be more open than it has been. It probably is not going to have any impact in this area until, in 1984, the VIIIth Plenary of CCITT, for instance, adopts a resolution to explore this situation and hopefully, to achieve a plan during the following study period.

7. THE FUTURE OF INTERNATIONAL STANDARDS

In order to cope with the above situation, we need automation, reorganization, preference of International Standards over National, and broader base participation. Specifically, in automation we have had a start in a number of relatively isolated disjoint instances where the major Standards Writing Organizations and the administrative Bodies have started to automate the Standards Writing Process and the management thereof. In terms of management, the control of Documents has been helped by Automated Document Registers, Automatic Status Reporting of the progress of a Draft Standard through balloting, commenting, reconciliation of adverse comments and votes. These ease the administrative load, but in no way help the process of any Document per se. These processes have been started in at least three or four Member Body operations, and are also being initiated in the Central Secretariat. As this becomes a more common usage and as the information can be electronically communicated to all participants, there will be a substantial speedup in most administrative processes.

Automation will also help in the progress of the document itself. From the time that the document is a Draft Standard, it can be placed in a Word Processing Data Bank, even if one language alone. This recording makes it immediately more easy to cope with, making the corrections to the text, comments in the balloting process, and the conversion from one editorial structure to another, should that be necessary. This helps the Draft Standards portion of the process, something that is probably the most time consuming part of the operation. In the Committee I chair and in 97/16 which deals with the Reference Model, there are usually three or four major versions put out to ballot at Working Group up to TC level of a particular Draft Standard. The differences from the first to the last could be 20 to 40% of content. To have these things done on a Data Base would represent a considerable simplification.

8. RAPPORTEUR/EDITOR

We'd like to bring forward another idea. That is the Rapporteur. This position has worked well in the CCITT, in ISO/TC97/SC16, and in ISO/TC97/SC6's

vocabulary project. If each DP is associated with its own Rapporteur or Editor, this editorial work can be expedited a great deal more than it has been in the past. Rapporteurs/Editors have been used from time to time: such as on HDLC. The ISO Central Secretariat are taking steps of realigning their Staff insofar as processing of a DP and its subsequent DIS and Publication are concerned. It should be possible for an Editor to have a single point of contact in the ISO Central Secretariat.

9. EDITORIAL CONTROL AND AUTOMATION

There is an area in the Central Secretariat operation where important changes are being made. That is in the actual publication process. ISO documents have a definite format. We must be able to ensure that the text, which is now technically accurate, conforms to that format, and is ready for publication (by whatever printing means) at the earliest stage of the process. This will be accomplished by automation in Central Secretariat office. If these several steps of automation can be harmonized, wherever the Data Base or Bases may be kept, I would predict a savings in elapsed time to produce a Standard of 24 to 44 years, achieved over a period of 3 or 4 years.

10. WORKING GROUPS: AUTHORITY AND RESPONSIBILITY

We have long ago recognized the very vital role of our Working Groups. It turns out that in TC97, Sub-Committees 6, 16 and 18, are much more prolific and entrust much more work to their Working Groups than the average ISO, TC and SC's do. These people meet much more often than the average, even of the rest of TC97. Much valuable work has been done by these Working Groups as Standards Writers: they should not be viewed merely as Technical Debating Groups. We must speed up the process, minimize the steps through which a document must pass and yet retain document control, and utilize, in the most expeditious way, the opportunity for Member Bodies to express themselves. Working Groups should have more responsibility delegated to them (eg. full determination and recommend action for registration of a DP), and more accountability (eg. have the majority of their participants appointed by Member Bodies, with National positions and instructions.) These improvements would need changes in ISO Directives, and there are alternative proposals to work toward the same end. There has been profound use made of Working Groups and Ad hoc Groups authorized by other Ad hoc Groups, or by SC's in some cases and by TC's in a few cases. All of these things are in accordance with ISO Directives, but in practice, there are many TC's that have no SC's, much less Working Groups, and the Working Groups are essentially sunsetted, having only brief periods of life toward one purpose as opposed to a general charter of some sort. The ideas on restructuring below, do not conflict with these ideas on

operational changes.

11. RESTRUCTURING OF TC'S

For TC97, at least, there is need to structure TC's, SC's, Working Groups and one level of Ad hoc Committees as well as to formalize various Rapporteurs and Editors. And the impact of this on the rest of ISO operation and/or the ability to not increase the overhead of balloting will cause some kind of reorganization in ISO operations. It is premature for me to say what will happen, but suffice it to indicate at this point that proposals are coming forward for a redefinition of those organizational levels (which would affect all of ISO); other proposals for the creation of a new technical division for which TC97 would be, if not the complete Division, the major contribution to it.

12. REORGANIZATION

A third family of proposals involve a merger of the ISO and the IEC, with the creation of new Technical Divisions better aligned amongst TC's of both organizations. The latter proposals are more difficult and time consuming to achieve, should they be desired, because they would require fundamental changes in the makeup of these organizations and the attendant approval of Member Bodies. No matter how much further it may go, it appears that a trial operation of TC97 in a new or autonomous mode may take place under the authority of a PLACO decision, 6 months to a year's trial operation of which might be observed before the next Plenary of TC97 which will occur in 1984. Needless to say, unless corresponding reorganizations of ISO and/or IEC "TAGS" occur within the countries, much of the international benefit in time saving will not be realized. In fact, the National actions will probably have to occur first, since it is National voting that produces International actions.

All major reorganizations must face up to the current differences between ISO and IEC. One such difference is the fundamental concept of ISO Member Bodies vs a "National Committee" for the IEC. And in some cases the National Committee hierarchy represent entrenched interests which are hard to overcome. Within the ISO and IEC, since both members would be involved in reorganizational steps, there are numerous minor procedural differences on the administrative side in particular, that need to be harmonized before merged operation of any of their units can be accomplished. There are good procedures in both organizations and there likewise are procedures that are frustrating, if not useless for the rapidly moving Communications and Information Industry. Some of the procedures came about merely from independent origination and operation; others as a result of the degree of de-centralization or centralization (the IEC being more centralized). In any case, I see no problem except ensure that there is the will to achieve such harmonization.

13. NATIONAL VS INTERNATIONAL CONSIDERATIONS

A shift is taking place in the predominance of National or International level activities. When I first became involved in International Standards the technique was to submit to the International arena what had been worked out in your country, and then hope that the rest of the world would accept it. This was an easy thing for a technological leader to do. No one else had the current expertise to debate many of the specific, sophisticated statements. But as technology spread the technological leaders didn't always get the first contribution on file, and when they did file, they usually received very competent comments, possibly disagreeing with their proposal. The result of this trend to spread technological capability has prevented any specific kind of National dominance, and in the minds of a number of the key workers in this field, it is probably the best tactic today to bring International and National activity along at comparable speeds. In other words, a National Body should submit their draft of Technical Standards to the International arena and describe the level of National coordination it has received; then attempt to defend the National level, but nevertheless, flexibly negotiate an international position. This procedure recognizes that in the Nationally unique application, and for certain national laws or regulations, there might be differences, and of course, the National Document must reflect them. However, where such differences are not mandated, it should become the practice to use the International Standard as such with a National cover overlay. Combining this concept with the Technical Publication situation of the Common Database, it becomes clear that each National Body could have the text in the primary language of International Standards and/or in its own legal language and be able to print as required as soon as the International vote has been certified to be favorable.

As we have said briefly above, no large Member Body can inflict its National Standards onto an International Committee as a contribution without having other competent Bodies produce contributions and comments of equal quality, and possibly of different technical content and approach. No small Member Body, on the other hand, could spend the money to develop a complete National Standard unless it goes to International meetings and interacts with all International experts. As the Standards get larger and more complex, it is only natural that the basic arena will be International Standards Committee.

In addition we have observed that there is much more Standards writing activity taking place outside the classical Member Body Committees. Professional Societies, Regional groups of one kind or another, buyers and sellers of components, specialized Governmental agencies, are all writing Standards to some degree for their particular interests, and through their Member Bodies,

they are putting the contributions into the International arena. In fact, when the professional society might be multi-national, you might expect concerted action from several International Member Body constituents. ISO/TC97/SC6 recently recognized this by assigning a liaison person to IFIP/TC6.

14. MULTI-YEAR-PLANNING

In the past, a Committee's Chairman and Secretariat have waited for a potential host to come forward with his invitation. In TC97's highly active SC's, we are now taking the liberty of sketching out a multi-year, advance-planning look at who might be the host. We don't wish to take away the prerogative, but we wish to further improve the forward look so that the various considerations of planning, financial, availability of space, and relationship to other meetings, are carried out before it becomes a crisis. There are other aspects of our new multi-year planning, including establishment of completion dates for DP's and DIS's, and the frequency of meetings, all of which are mutually interdependent.

15. DIVERSITY OF PARTICIPATION

We have come back to the fact that we never have enough different points of view in the International Standards process. Always more users interests are welcomed. Labor Unions, Service Organizations, Consumer Groups, and Specific lines of business are major sources of additional areas that we like to see. And as systems get more complex the numbers of organizations or groups of experts increase. The fact that we have not stopped calling for increased contributions means that we don't feel we have all bases covered, nor are all users educated through the Standards process itself, in how to apply the Standard.

16. CONCLUSIONS

Advancing technology and the trade demand of increased applications are producing an active program of development for International Systems Standards, and that these Standards lay on top of many of the Hardware, Component, Language and Link Procedures Standards that we have been known to have today. The number of competing varieties at each of those levels is also increasing. In the words of the Reference Model, at Level 1, we have Plain Copper Interconnection, say for inside building wiring, Local Area Networks, the Public Switched Voice Networks, Public Switched Data Networks, ISDN's and Satellite Links. At Level 7 we have Banking, Health Care, Manufacturing, Office Automation, among other lines of business applications. All of which can put their application on the same computer and transmit their data over the same communication facilities. The changes that are involved are wide-sweeping. While most of the old experts are still in the game, there are many more new ones, with different backgrounds. Their presence and

participation imply technical, political, social and economic changes. Unless these changes also improve the cost and the output of the process, the process itself may die because the people who need it will not stay in an inefficient and archaic environment.

While I could speculate further on what changes might be coming, I think the areas of automation, reorganization, harmonization, international priority over National, in Standards development, and the increased number of participants are the key trends for the future.

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NETWORK DIGITAL STANDARDS
as related to
Interoperability between CCITT North American, European, and
Government digital transmission hierarchies.

B. J. Murdock
Collins Transmission Systems Division
Rockwell International
Dallas, Texas

1. Abstract

Effective "interoperability" between digital networks within both the national and international arena, depends to a large degree upon the acceptance and coexistence of reasonably compatible digital and analog hierarchy standards and interfaces. For economic as well as overall technical reasons, analog and digital networks must coexist for sometime into the future -- while the evolutionary implementation process towards a predominantly digital world takes place. A look at some very positive aspects of where we are, and where we may go from here, is presented.

Interoperability, according to the US Military JCS, is defined as:

"Interoperability -- the ability of systems, units or forces to provide services to and accept services from other systems, units or forces, and to use the service so exchanged to enable them to operate effectively together."

We don't live in a totally ideal world, therefore, the maximum degree to which "operate effectively together" can be attained in terms of practical digital interface compatibility -- represents the theme to which this paper is addressed:

It equally applies to both Domestic and International -- encompassing the commercial, civil government, and military environments -- as each separately relates to the others.

- For legitimate and understandable reasons, different standards have developed over time throughout the world. Several digital hierarchies are reviewed with salient features identified for comparison.
- A COMBINED standard is presented that is currently under consideration for implementation in the Philippines. It would allow for efficient nationwide interconnect between commercial, civil government, and military transmission facilities. The considered COMBINED standard -- offers advantages through the use of spectrum efficient CCITT North American digital radio transmission standards -- and the lower level CCITT European PCM hierarchy encompassing Common Channel Signaling (CCS).

2. BACKGROUND

Fortunately, throughout the world, standard digital port rates have been standardized to the extent -- they are derived from the 8000N family hierarchy for rates above 32 kb/s. Typically, the 8000N family is used down to 8000 bits per second (b/s). For low-speed data, the Cx75x2^N family hierarchy will continue in use from 75 b/s up to 9.6, 14.4,

19.2, and even 38.4 kb/s -- with 1200-, 2400-, 4800-, and 9600-baud equipment in extensive use today.

Two directives (figure 1) together with European CCITT hierarchy and operational interface definitions, assure ultimately -- a reasonable degree of success for compatibility/interoperability:

Directive 1. 8000N for the TRITAC AN/TTC-39 hybrid switch and related transmission segment developments -- which changed planned tactical 19.2- and 38.4-kb/s channel rates to 16- and 32-kb/s 8000 rates for the tactical military's Continuously Variable Slope Delta (CVSD) type field implementations.

Directive 2. FCC Docket 19311, which based the digital microwave hierarchy to be consistent with the FCC bandwidth restricted MASK -- which called for at least 1152 channels (integral numbers of DS1). Practical implementation for 1344 (two DS3) channels followed, which is integral up to DS3 -- rather than 1200 equivalent PCM channels per radio.

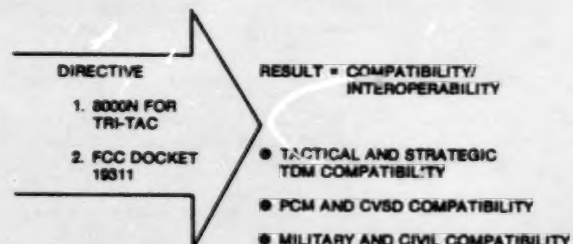


FIGURE 1. DIRECTIVES.

2.1 REGULATORY

Digital network's hardware development was hampered for lack of regulatory policies until the two directives, ie, TRITAC-1972 and FCC Doc #11 19311-1974, establish the appropriate guidelines -- which allowed development to move forward. In addition, the two directives mutually supported subsequent selection of DS1 (1.544 Mb/s) and 12.928 Mb/s (1616 N, where N = 8000) for the US Military standard strategic rates, particularly for where bulk encryption was to be effected. 64 kb/s (DS0) per channel has become the standard channel bandwidth module (worldwide) for:

- International commercial
- Civil government
- Strategic military use.

Repeating, the MASK requirements of FCC Docket 19311 for Line-of-Site (LOS) microwave -- requires TDM implementation of at least 1152 equivalent 64-kb/s PCM channels (8-kb/s sampling and 8-bit encoding) per microwave radio -- contained within:

BAND	BANDWIDTH
4 GHz	20 MHz
6 GHz	30 MHz
11 GHz	40 MHz

The criteria established implemented bit-per-bandwidth efficiencies, respectively, of better than 2, 3, and 4 bits/Hz (figure 2).

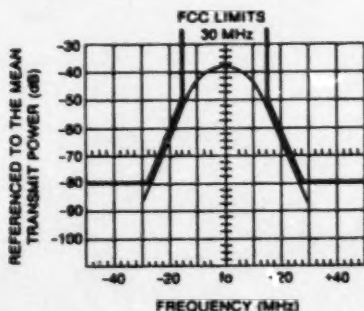


FIGURE 2. MDR-6 TYPICAL TRANSMIT SPECTRUM.

Current developments using 64 QAM modulation -- will implement three standard 44.7-Mb/s DS3 ports into a single 6- or 8-GHz radio -- within the 30-MHz bandwidth allocation, ie, 4.5 bits/Hz (equivalent to 2016 equivalent PCM channels). This also allows two DS3's to be placed within 20-MHz allocated bandwidth at 4 GHz (1344 equivalent PCM channels).

3. DIGITAL STANDARDS

The widely used and accepted digital standards considered are:

- CCITT Rec G.732 and G.742/G.751 (commonly referred to as "European")

- CCITT Rec G.733 and G.743/G.752 (commonly referred to as "North American")

- Government (typically divided into Tactical and Strategic).

Figure 3, taken from the proposed draft Philippine Transmission Plan -- illustrates the comparative salient features of: the CCITT (European Rec G.732/742/751) and the CCITT (North American Rec G.733/743/752) digital hierarchies.

Also illustrated is the proposed COMBINED standards plan considered for the Philippines. Each standard will be treated separately.

3.1 CCITT (EUROPEAN) PER REC G.732 and G.742/G.751

As shown on figure 3, this standard features 64 kb/s per voice channel, ie, sampling takes place at an 8-kHz rate, thus meeting the Nyquist criteria -- with samples encoded to 256 levels (8-bit words). Thus the quantizing noise floor is adequately lowered for toll-quality transmission. Thirty customer Mission Bit Stream (MBS) channels plus two common signaling channels are multiplexed to the Rec G.732 standard 2.048-Mb/s rate (30 + 2).

Four 2.048-Mb/s channels are asynchronously multiplexed to the 8.448-Mb/s level, four 8.448-Mb/s ports are multiplexed to the 34.236-Mb/s level, and four 34.236-Mb/s ports are multiplexed to the 139.368-Mb/s level per Rec G.751.

According to the "A" law, companding provides for 12 segments -- as compared to 15 segments for the North American "μ" law system.

TRANSMISSION STANDARDS

VOICE CIRCUITS IN EACH 30-MHz RADIO CHANNEL

	CCITT STANDARD EUROPEAN	COMBINED STANDARDS (2)	CCITT STANDARD NORTH AMERICAN
EACH VOICE CHANNEL	64 kb/s	64 kb/s	64 kb/s
FIRST MULTIPLEX	30 + 2 (2 Mb/s)	30 + 2 (2 Mb/s)	34 (1.8 Mb/s)
SECOND MULTIPLEX	4 (30 + 2) = 120 + 8 (8 Mb/s)	3 (30 + 2) = 90 + 6 (6.3 Mb/s)	4 x 34 = 96 (6.3 Mb/s)
THIRD MULTIPLEX	4 (120 + 8) = 480 + 32 (34 Mb/s)	7 (90 + 6) = 630 + 42 (48 Mb/s)	7 x 96 = 672 (48 Mb/s)
FOURTH MULTIPLEX (1)	4 (480 + 32) = 1920 + 128 (144 Mb/s)	7 (630 + 42) = 4410 + 252 (374 Mb/s)	8 x 672 = 5376 (274 Mb/s)

- NOTE: 1. A 30-MHz MICROWAVE CHANNEL CAN TRANSMIT THE THIRD ORDER MULTIPLEX BUT NOT THE FOURTH. IT MAY BE POSSIBLE IN THE NEAR FUTURE TO DOUBLE THE THIRD ORDER MULTIPLEX IN ALL CASES.
2. THE INTERMEDIATE ARRANGEMENT CHANGES FROM ONE CCITT STANDARD TO THE OTHER AT THEIR COMMON POINT, 96 VOICE CHANNEL (6.3 Mb/s).

(TAKEN FROM PROPOSED PHILIPPINE TRANSMISSION PLAN)

Courtesy of:

International, Inc.

FIGURE 3. TRANSMISSION STANDARDS.

At the expense of lower bit efficiency, European 2.048-Mb/s systems disperse 128 (2 channels equivalent) overhead (OH) bits along with 8-bit byte groups of the 30 bytes (8-bit encoded) per frame, ie:

More overhead bits are available for more sophisticated framing, signaling, and control, as compared to CCITT Rec G.733 (should this be a desired trade-off)

	FRAMING CODE
	$30 \times 8 = 240$
	$240 \times 8000 = 1920k$
	$1920k + 128 = 2.048 \text{ Mb/s}$

Interconnect with analog transmission (European or North American) can be wasteful, ie:

- Both European and North American CCITT FDM standard analog hierarchy -- employ 12 equivalent voice channels per basegroup (60-108 kHz), and 5 basegroups (60 channels) per supergroup. While analog to CCITT European digital interconnection is very efficient at the 60- or 120-channel level, it is less efficient at the 12-channel basegroup level (2-1/2 analog basegroups) -- typically a 6-channel mismatch.

- Equipment manufacturers would typically plan to employ digital subscriber loops from digital switches via wire to end-customer premises, which would implement 144 kb/s, equal to two 64-kb/s channels, independently switched and routed, plus 16 kb/s for signaling/synchronization and technical control.

The format is defined typically as: $64 \times n + \Delta$ (where $n = 2$ and $\Delta = 16 \text{ kb/s}$. This is consistent with recent work accomplished by CCITT study group XVIII.

- Common channel signaling can be effective -- particularly in terms of the switching segment of networks.

3.2 CCITT (NORTH AMERICAN) PER REC G.733 AND G.743/G.752 (REFERENCE FIGURE 3)

For CCITT North American, figure 3 illustrates 64 kb/s allocated per voice channel, ie, as with the European 2.048-Mb/s standard -- sampling takes place at an 8-kHz rate, thus meeting the Nyquist sampling criteria, with samples encoded to 256 levels (8-bit word). Twenty-four channels are multiplexed to make up the DS1 (1.544-Mb/s) first level rate:

$$24 \times 8 = 192$$

$$192 \times 1 = 193 \text{ bits/frame}$$

$$193 \times 8000 = 1.544 \text{ Mb/s}$$

Four DS1 channels are asynchronously multiplexed to the DS2 (6.3-Mb/s) level, seven DS2 ports to the DS3 (44.7-Mb/s) level, and six DS3 ports to the DS4 (274-Mb/s) level.

A variation of the CCITT Rec G.733 and G.743/G.752, North American standard is implemented in Japan, where the hierarchies are identical up to the DS2 (6.312-Mb/s) level. The next two Japanese levels are 480 channels (32.064 Mb/s), and 1440 channels (97.728 Mb/s).

As stated under Rec G.733, companding is according to the 15-segment μ law, and although common channel signaling can be employed, typical signaling is in-band (common with the channel MBS). Signaling accompanies the MBS throughout the transmission system. Toll-quality performance is assured through use of modern type D3 or D4 channel banks -- by taking the eighth bit of each sixth 8-bit byte for signaling. This provides for toll-quality transmission, with advantages attendant to in-band signaling.

Digital radio or span-line cable interconnects with analog facilities efficiently at the 24-channel digroup level (worldwide).

3.2.1 DS0 (64 kb/s) INTERNATIONAL INTERCONNECT AND DS1 (1.544 Mb/s) EXTENDED FRAME CRITERIA

AT&T Technical Advisory No. 69, dated 30 April 1981, treats an evolution toward an Integrated Services Digital Network (ISDN), whereby all new next generation DS1 equipment to be designed for the Bell System, will include provisions for Clear Channel, DS0 and DS1 Capability, unconstrained by ones density or number of consecutive zeros requirement.

At the DS1 level, 8 Zero Substitution Coding (8ZSC) replaces any eight consecutive zeros of the DS1 signal.

If the pulse preceding the inserted code is transmitted as a positive pulse (+), the inserted code is 000 +-0-+. Bipolar violations occur in the fourth and seventh bit position of the inserted code. If the pulse preceding the inserted code is a negative pulse (-), the inserted code is 000 -+0-+.

"Through normal evolution, significant deployment of equipment with Clear Channel Capability is expected in the 1990 time frame."

AT&T Compatibility Bulletin No. 142, dated 29 September 1981, describes the new DS1 level framing format. "The F_0 framing format 'extends' the DS1 superframe structure from 12 to 24 frames (4632 bits) and redefines the 8-kb/s (framing bit position) pattern previously used for mainframe and robbed bit signaling synchronization into 2 kb/s for mainframe and robbed bit signaling synchronization."

The Extended Framing Format provides for: (1) 2 kb/s for Cyclic Redundancy Check Code (CRC-6), and (2) a 4-kb/s DS1 to DS1 (terminal to terminal) data link. The 4 kb/s data link will use the BX.25 level 2 protocol and "Functional Destination" operation code structure. By extending the superframe from 12 to 24 frames, up to 16 signaling states are possible.

A number of applications for the data link are under consideration.

Bulletin No. 142 projects the Extended-Superframe (ESF) to be according to table 1.

TABLE 1. EXTENDED-SUPERFRAME (ESF) F-BIT ASSIGNMENTS OF THE EXTENDED FRAMING FORMAT.

ESF FRAME NUMBER	ESF BIT NUMBER	F-BITS ASSIGNMENTS			ROBBED BIT SIGNALING
		FPS	FDL	CRC	
1	0	-	m	-	A
2	193	-	-	CB ₁	
3	386	-	m	-	
4	579	0	-	-	
5	772	-	m	-	
6	965	-	-	CB ₂	
7	1158	-	m	-	B
8	1351	0	-	-	
9	1544	-	m	-	
10	1737	-	-	CB ₃	
11	1930	-	m	-	
12	2123	1	-	-	
13	2316	-	m	-	C
14	2509	-	-	CB ₄	
15	2702	-	m	-	
16	2895	0	-	-	
17	3088	-	m	-	
18	3281	-	-	CB ₅	
19	3474	-	m	-	D
20	3667	1	-	-	
21	3860	-	m	-	
22	4053	-	-	CB ₆	
23	4246	-	m	-	
24	4439	1	-	-	

FPS - Framing Pattern Sequence (001011)
 FDL - 4 kb/s Facility Data Link (message bits m)
 CRC - CRC-6 Block-Check Field (check bits CB₁-CB₆)

3.2.2 CHANNEL BANKS (DATA PORTS FOR DATA COMM) -- REFERENCE FIGURES 4 AND 5

DS1 codec per-channel data-port option channel banks have experienced extensive in-service use. As an example, the Rockwell 360-D4 exhibits a digital backplane interface, rather than the older analog PAM interface, by use of individual channel codecs. Simply, the analog/digital/analog (A/D/A) function is separated from the 24-channel Time-Division Multiplex (TDM) function at the channel card interface with the backplane, thus providing easy access to the TDM signal bus.

This new generation concept permits optional use of encoding schemes, providing for a greater signal-to-noise ratio and/or dynamic range than would typically be available, dependent on companding laws in use today.

Unlike other types of channel bank architecture, the codec per-channel hardware effects essentially no cost penalty to predominantly all telephony (voice/analog) users -- when considering initial or potential exchange of PCM voice channel slot cards with data option cards. Thus, real economic flexibility is provided for data plus voice (particularly for 9600-baud and above data channel rate requirements) to be implemented within a

single 64-kb/s voice channel slot assignment. Higher rates (adapted to multiples of 64 kb/s) and program channel rates are available (figure 5).

3.3 COMBINED STANDARD (REFERENCE FIGURE 3)

The proposed COMBINED standard takes full advantage of the pro and con features as applicable to the two accepted CCITT standards -- by reaching a common transparent medium at the DS2 (6.312-Mb/s) level. In lieu of four DS1 Rec. G.733 1.544-Mb/s ports normally combined to the DS2 6.312-Mb/s level, three CCITT Rec 732 2.048-Mb/s ports are combined to this same level via use of a single exchangeable card.

This allows for: (1) the option of CCITT Rec G.732 switching, companding, and common channel signaling CCS at the 2.048-Mb/s level -- with CCITT Rec G.743/751 upper level standard hierarchy used at and above the 6.312-Mb/s transparent rates of the TDM -- and (2) the advantage of maximum implemented bit usage efficiencies on digital radios.

3.3.1 FRAMING CODE

- Rockwell has devised a frame format (framing code) which will allow the interfacing of Rec G.732 2.048-Mb/s compatible data streams with a single Rec G.743 DS2 6.312-Mb/s data stream. The data from three 2.048-Mb/s tributaries are bit interleaved and ordered in a sequential manner. Asynchronous multiplexing is accomplished by using positive justification with a justification ratio of 0.69. The justification control bits C_n are distributed through the frame.

The frame format contains a parity bit whose value is determined by the digital sum of the data bits, while the digital sum of the data bits when added in a binary manner with the parity bit equals zero.

The C_i bits are used to send channel loop-back information, and the M_x bits are an uncommitted bit that can be used as desired.

3.3.2 ADVANTAGES AND APPLICABILITY

Like many developing nations, the Philippines moved forward toward digital network implementation (both switching and transmission), and was faced with a combination of proposed digital standards.

There are several advantages for consideration of this overall arrangement of COMBINED standards, particularly as related to the projected needs of the Philippines:

- For LOS microwave, the COMBINED standards permit maximum use of the RF system in terms of spectrum conservation (using available hardware).
- Zero loss in bit efficiency exists in interconnecting (96-channel blocks) in either direction. Simply, the mathematics equates to:

360 CHANNEL BANK — COMPATIBLE OPERATION

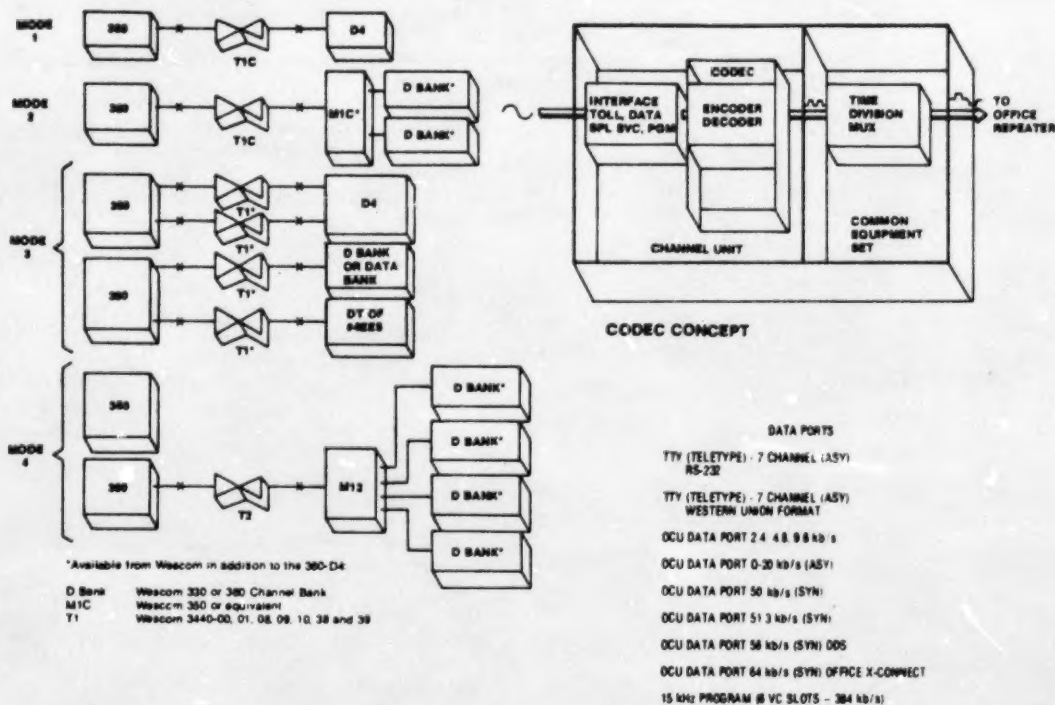


FIGURE 4. 360-D4 CHANNEL BANK (ROCKWELL).

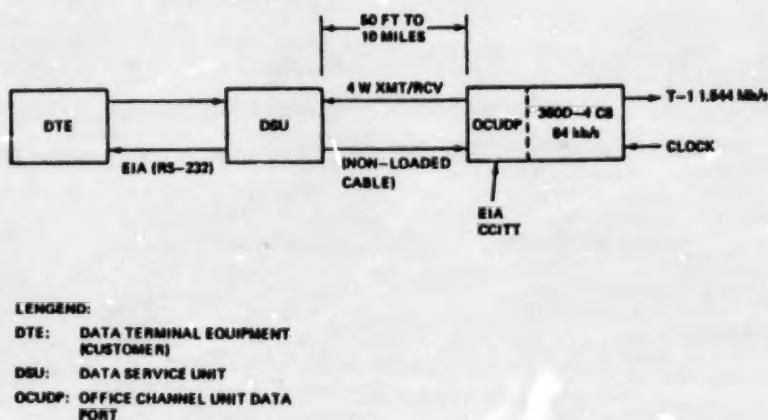


FIGURE 5. 360-D4 CHANNEL BANK (DATA COMM).

3 x 32 = 96 64-kb/s equivalent channels
(6.3 Mb/s)

4 x 24 = 96 64-kb/s equivalent channels
(6.3 Mb/s)

- It implements the maximum number of digital PCM channels (practical today) onto a single radio channel, attendant with CCITT G.743/752 upper level hierarchy. This would also be true as projected forward (terms of available hardware).
- The Rec G.751 alternative at 34 Mb/s is (480 + 32) channels -- as compared to (630 + 42) for the COMBINED standards.

- Related to typical networks like in the Philippines, the proposed COMBINED standard could effectively interoperate/ interconnect:

- Between the evolving civil backbone digital systems
- Between these civil systems and the AFP Military CCITT, Rec G.743/752, North American standard network.

- Efficient interconnect would be on a three 2.048-Mb/s to/from a four 1.544-Mb/s port basis. Illustrations, ie, typical interconnect evolution between various civil and military networks, are shown (figures 6 and 7).

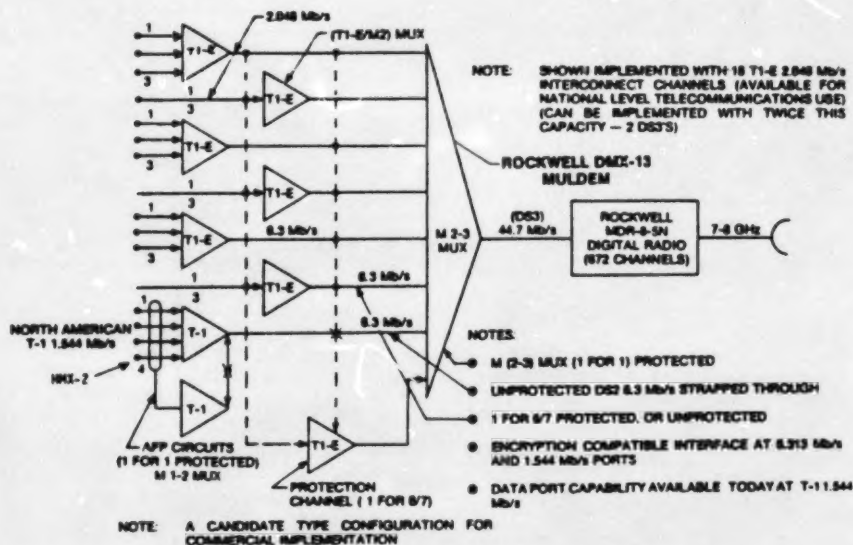


FIGURE 6. BACKBONE MICROWAVE -- CANDIDATE IMPLEMENTATION.

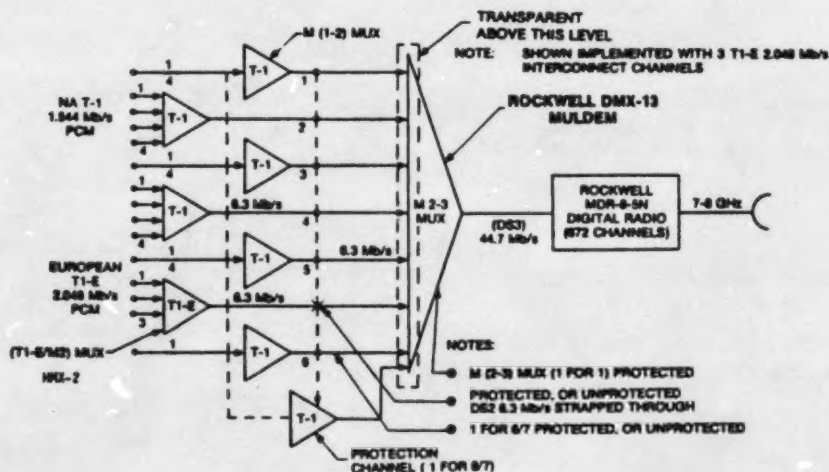


FIGURE 7. BACKBONE MICROWAVE -- ARMED FORCES OF THE PHILIPPINES.

- Real alternate route reconstitution/restoral capability is accomplished in the support of natural and/or military emergencies.

3.4 GOVERNMENT STANDARDS

In most countries, government digital standards are divided into: (1) civil government and (2) military. Both are in the normal case controlled and/or operated by administrations of national governments.

- Civil government standards, generally, are the same as those enforced on the commercial (business) needs area, whether the business services are operated and/or regulated by the National Administrations (PTT's) or not. Accordingly, CCITT, Rec G.733 and G.743/752 (North American) or CCITT, Rec G.732 and G.742/751 (European) standards could apply where appropriate in various areas of the world -- in particular to underdeveloped areas.
- Military needs can be, and usually are, rather special and demanding -- composed of both tactical and strategic. It follows that needs, as applicable to military standards, are also different from those applied to the commercial and/or civil government sectors.

3.4.1 TACTICAL

Because of bandwidth limitations as imposed by transmission constraints applicable to VHF and UHF mobile and fixed tactical military hardware -- 64-kb/s PCM overly restricts needed channel capacity for the tactical military. The need is satisfied with less allocated bits per channel.

Tactical per-channel bit rates of 8, 16, and 32 kb/s for Continuously Variable Slope Delta (CVSD) digital conversion are replacing the older 48-kb/s (8000-Hz sampling with 6-bit encoding) PCM systems (TD-660 family). Synchronous 8000N highway rates of 128, 256, 512, 1024, 1536, and 2048 are now typically employed for TRITAC and EUROCOM tactical military systems.

As the common per-channel bit rate is lowered from toll-quality 64 kb/s, CVSD begins to outperform PCM. An example -- the quantizing noise floor for 32 kb/s PCM, as compared to 64 kb/s PCM -- (where both are sampled adequately at a Nyquist 8000-Hz rate), is 24 dB worse.

Military subscriber, synchronous end-user cable loops -- employ conditioned diphas (a form of Manchester) coding. This technique in effect doubles the bit rate, but effects an efficient scheme for data randomizing and the related ease of clock recovery. The scheme is also essentially transparent in terms of supporting variable bit rate transmission.

3.4.2 STRATEGIC

Strategic circuits constitute the "Long Lines" of the military -- implemented for both wartime and

peacetime critical communication needs. Strategic military transmission channel capacity, as compared to common carriers, is normally lower -- ie, typically 96, 192, 384, 672, up to 1344 etc channels per trunk cross-section. Here we are treating typical telecommunication needs that do not employ such techniques as spread spectrum, frequency hopping, antenna null steering, etc. Therefore, we are not treating special needs requiring such schemes as bandspreading for antijamming (AJ).

Standard port rates (64 kb/s and 1.544, 2.048, 6.312, 12.928, 44.7 Mb/s plus other upper level multiplexer levels) represent the more important standard rates employed.

Between levels 2 and 3 of either G.742 or G.743 hierarchies, there exists no medium-density standard rate.

(6.312/8.448) Mb/s -- VOID -- (34.236/44.7 Mb/s)

1616N (where N = 8000) equates to 12.928 Mb/s

12.928 Mb/s effectively fills this void for the US strategic military -- thus providing for eight 1.544-Mb/s ports, six 2.048-Mb/s ports, or for a 3/4 ratio combination. Two 12.928-Mb/s ports are combined via the radio to 25 Mb/s, or optionally a single port is transmitted -- or three 12.928-Mb/s ports along with three 1.544-Mb/s are TDM combined to the DS3 (44.7-Mb/s) level. [Ref Washington Area Wideband System (WAWS) -- figures 8 and 10].

NOTE: The WAWS system digital channels are leased by Western Union to the US Government.

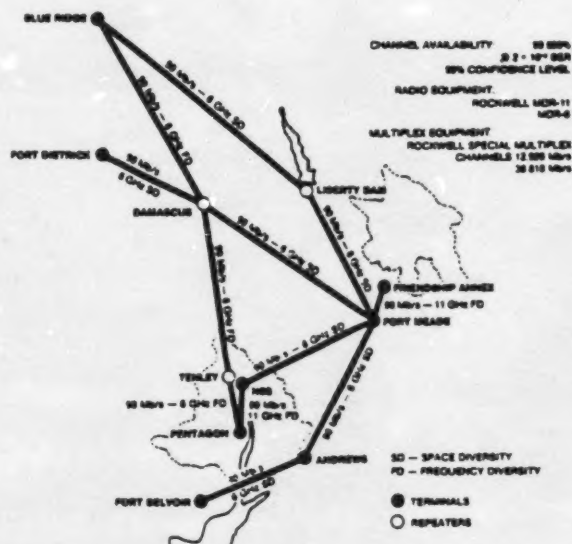


FIGURE 8. WAWS RADIO CONFIGURATION.



FIGURE 9. AFP MICROWAVE SYSTEMS.

Most upper level bulk encryption today, takes place at 12.928 Mb/s -- and since there exists no other standard rate to satisfy this medium-density need, the rate is becoming a universal standard -- for use beyond strictly strategic military needs (figure 10).

4. SUMMARY

The COMBINED standard and further implementation of 1616N are worthy of serious consideration by those responsible for national and international network planning and implementation.

5. BIBLIOGRAPHY

1. Various CCITT and CCIR Recommendations
2. Technical Advisory No. 69 (AT&T), "Clear Channel Capacity"
3. Technical Advisory No. 34 (AT&T), "Interconnection Specification for Digital Cross-Connects -- Issue 3"
4. Compatibility Bulletin No. 142 (AT&T), "The Extended Framing Format Interface Specifications"

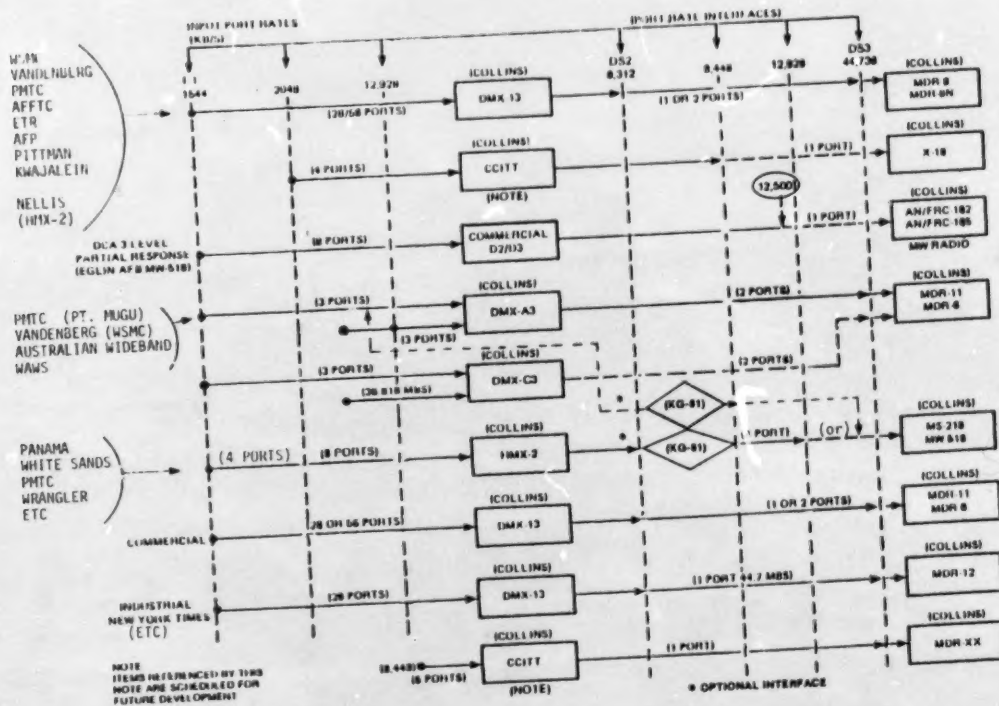


FIGURE 10. TDM HIERARCHY, UPPER LEVEL MULTIPLEXER.

The layer model and error control
for satellite communications

T. Shikama, Y. Ujihashi, C. Matsuda
Information Systems and Electronics Development Laboratory
Mitsubishi Electric Corporation, Japan

H. Takahashi
Radio Research Laboratories
Ministry of Posts and Telecommunications, Japan

Abstract

This paper is concerned with the location of the layer functions for the satellite computer network in which packet multiple-access scheme is employed. The relation between the layer model and error control is discussed in accordance with the ISO Reference Model. We propose the location of the lower layer functions, where multiple-access, error detection, and retransmission are placed in the connectionless Data Link Layer, and error recovery, sequencing, and flow control are placed in the connection-oriented Transport Layer. By the simulation, it is revealed that the proposed scheme has small overhead and the network delay is reduced by the retransmission in the Data Link Layer.

1. INTRODUCTION

Recently, the satellite communications have come to be employed for computer networks. We developed an experimental computer network system using the Medium Capacity Communication Satellite for Experimental Purpose (MCS), and its experiments have been carried out by Radio Research Laboratories (1), (2). Through these experiments, the performance of the protocols such as the access schemes and the data link control procedure has been evaluated.

The satellite communications have the properties of the multiple-access and broadcast nature, which enable every station to communicate with every other station through one link. On the other hand, the satellite communications have a long propagation delay, which gives a great impact on the performance of the network. For the satellite computer network, it is desirable to be constructed by the architecture which makes good use of the multiple-access and broadcast nature and takes account of a long propagation delay.

The computer networks generally take the structure of hierarchical layers. The ISO/TC97/SC16 defines the Reference Model of Open Systems Interconnection for the layered structure (3). Figure 1 illustrates the ISO Reference Model. We are studying a computer network that is suitable for the properties of satellite channels on the basis of the Reference Model as well as the results obtained by the experiments. The ISO Reference Model is defined on the basis of the connection, and connectionless-data-transmission is also under study now. This connectionless scheme is considered to be suitable for the satellite communications.

In this paper we discuss the location of the error control functions for satellite computer networks, and propose the new location of the layer functions. We show the effectiveness of the proposed location by the simulation technique.

APPLICATION LAYER (AL)
PRESENTATION LAYER (PrL)
SESSION LAYER (SL)
TRANSPORT LAYER (TL)
NETWORK LAYER (NL)
DATA LINK LAYER (DL)
PHYSICAL LAYER (PL)

Figure 1. The ISO Reference Model

2. THE LOCATION OF THE ACCESS CONTROL
FUNCTION IN THE LAYER MODEL

In general, a satellite channel is used to construct computer networks in the following two cases,

- 1) A satellite channel is controlled by a central switching station. Computers at user stations are assigned SCPC channels or TDMA time slots, and these are used as point-to-point transmission links.

- 2) A part of a satellite channel (ex. an SPCP channel) is shared by a group of user stations. And time is divided into slots, which are allocated dynamically to the user stations for the transmission of packets. The slot allocation is controlled distributively by the user stations. We call this scheme "packet multiple-access scheme" hereafter.

For the computers at the user stations, the satellite channels in the first case 1) are equivalent to terrestrial links (ex. the dedicated lines or circuit switched lines) except for the transmission delay. In this case, the access control is placed in the Physical Layer (PL) of the ISO Reference Model.

The second case 2) is inherent to the satellite channel which has the properties of the multiple-access and broadcast nature. It is well known that this scheme utilizes advantages of the satellite channel in computer networks, where the bursty traffic is generated. In this paper we deal with the satellite computer networks using this packet-multiple access scheme.

For this access scheme, we use the reservation scheme, which has the following functions (details will be described in section 4),

- o reservation of slots in a satellite channel
- o slot allocation
- o addressing
- o delimiting
- o packet transfer
- o expedited transfer of packet

These are the functions among the earth stations and are not in the Physical Layer. Furthermore, the reservation scheme operates without the connection between the earth stations. For these reasons, we place the access control function in the connectionless DL.

3. THE RELATION BETWEEN THE LAYER MODEL AND ERROR CONTROL

The ISO Reference Model defines that the link-by-link error control function is placed in the DL and the end-to-end error control function is placed in the Transport Layer (TL). For the data link protocol which is employed for a long delay satellite channel, HDLC with SREJ error recovery has been studied and experimented. For the transport protocol, the ISO/SC16 defines the transport protocols from class 0 to class 4 (4). Among these protocols, class 4 has the functions of the error recovery, flow control, sequencing, etc. and can be employed for the satellite communications.

In the network where a satellite channel is multiple-accessed by packets, every station can communicate with every other station through one link. In this case, both the DL and TL equally assure end-to-end error free. Therefore, it is sufficient that the error control is performed

in one of these two layers. We think that it is preferable that error control is performed in the TL in accordance with the concept of the Reference Model. In this case, the DL and the Network Layer (NL) should be made connectionless. The reasons are described in 3.1.

3.1 ADVANTAGES OF THE CONNECTIONLESS SCHEME

- 1) For the satellite computer network where the packet multiple-access is employed, the capacity of a satellite channel is dynamically allocated to the earth stations. And every earth station can communicate with every other station by a destination address of a packet. The connectionless scheme is suitable for making good use of those functions as well as the broadcast nature. And the control of the DL and NL can be made simple by the connectionless scheme.
- 2) The connectionless scheme does not have the overhead of a connection as described below. For the connection-oriented scheme the DL connection may be managed in two cases, that is,
 - o The all DL connections are established previously to make the fully connected network.
 - o The DL connection is established according to a demand.

In the former case, the number of connections increases according to the number of earth stations. In the latter case, the overhead due to the establishment and release of the connection decreases the satellite channel efficiency.

- 3) For the sequencing employed for the error recovery on a satellite channel, it is required that the packets received out of sequence are not discarded and retained until the successful receipt of the lost packets. In the case where the DL and NL are connectionless and the error recovery is performed in the TL, the sequencing is performed separately on each TL connection. On the other hand, in the case where the error recovery is performed in the connection-oriented DL, some TL connections may be multiplexed into one DL connection and the sequencing is performed on this DL connection. In this case (Figure 2a), the delay and the number of retained buffers are larger compared with the case of the connectionless DL (Figure 2b). When a packet which flows on a TL connection is lost, packets which flow on the other TL connection of the same DL connection may be delayed due to the sequencing. The connectionless scheme does not have this defect.

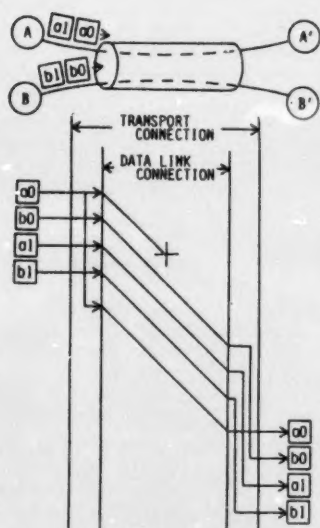


Figure 2a. Sequencing on a Data Link Connection in the case of the Connection-oriented DL

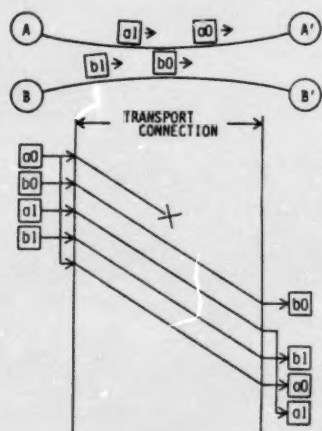


Figure 2b. Sequencing on a Transport Connection in the case of the Connectionless DL

3.2 THE RETRANSMISSION FUNCTION IN THE DL

In order to improve the performance of error control, we propose that the error detection and retransmission are performed in the DL, while making good use of the properties of the connectionless scheme described above. It is generally favorable for the error detection and the retransmission to be placed in the lower layer. In particular, for the satellite computer network in which the packet multiple-access is employed, the retransmission can be

efficiently carried out by implementing this function in the access control (5). The retransmission requires the detection of lost packets. This detection generally requires the connection between a sender and a receiver. For the packet satellite network, the acknowledgement can be piggybacked on the access control information. By using this function, the detection and retransmission of the lost packets can be performed efficiently in the connectionless scheme. However this retransmission may produce duplication of a packet and may leave some lost packets unrecovered. It is difficult for the connectionless DL to recover these duplication and loss of packets. It is sufficient that these are recovered in the TL.

3.3 THE LOCATION OF THE LAYER FUNCTIONS

On the basis of the considerations discussed above, we propose the location of the layer functions below the TL as illustrated in Figure 3.

TL	◦ CONNECTION-ORIENTED ◦ ERROR RECOVERY ◦ SEQUENCING ◦ FLOW CONTROL ◦ ACKNOWLEDGEMENT
NL	◦ CONNECTIONLESS
DL	◦ CONNECTIONLESS ◦ ACCESS CONTROL ◦ ERROR DETECTION ◦ RETRANSMISSION
PL	◦ MODULATION ◦ SYNCHRONIZATION

Figure 3. The Location of the Layer Functions below the TL

In the DL the functions of the access control, error detection, and retransmission are placed. This DL is connectionless. Due to the retransmission in the DL, the detection and the elimination of duplication and the sequencing are required, but these are performed in the TL. The NL is connectionless. The minimum functions, for example the data transfer, are performed in this layer. The TL is connection-oriented. The functions of the error recovery, sequencing, flow control, detection and elimination of duplication, etc. are performed in this layer. We employ the reservation scheme having the retransmission function for the DL protocol, and employ the protocol corresponding to the ISO class 4 Transport Protocol for the TL. This protocol has the following features.

- o The sequence space and window size are large.
- o The packets received out of sequence are not discarded.

For the location of the layer functions described above, the effectiveness and overhead of the retransmission by the connectionless DL as well as the performance and overhead of the transport protocol must be evaluated. These evaluations are carried out by the simulation technique described in section 4.

4. SIMULATION

To evaluate the proposed scheme, the simulation program was developed. The protocols employed in this simulation and the simulation conditions are described below.

4.1 RESERVATION SCHEME

For the access scheme which is placed in the DL, we used the reservation scheme. The basic requirements for the access scheme are as follows,

- o effective use of a satellite channel
- o small transmission delay
- o multiple priority levels according to the nature of traffic
- o fairness to competing earth stations
- o simplicity to control the network

Figure 4 shows the principle of this reservation scheme. A message is segmented into fixed-sized packets and time is divided into slots which have enough duration to transmit a packet. And a fixed number of slots constructs a cycle. Each cycle consists of a reservation region and a data region. A slot in a data region is called a data slot. In the reservation region a slot is further subdivided into subslots and each earth station has a fixed assignment of one subslot to send a reservation.

- 1) In every cycle each earth station sends a reservation which carries the information of the number of necessary slots for sending packets.
- 2) These reservations are received by every earth station via the broadcast satellite channel. The data slots of the next cycle are allocated according to the received reservations. This allocation process is carried out distributively at all earth stations with common algorithm. The format of the reservation enables the earth station to reserve data slots at several priority levels simultaneously. The data slots are allocated according to the priority level and if two or more earth stations intend to reserve them at the same priority level, they are allocated in the round-robin manner.
- 3) Each earth station sends packets in its allocated data slots.
- 4) A packet is received at a station directed by its destination address.

4.2 RETRANSMISSION IN THE DL

In the reservation scheme described in 4.1, the retransmission is carried out in the following method.

- 1) Each earth station sends a reservation with response information which indicates whether the earth station received a packet or not for each data slot in the previous cycle. This response information consists of several bits, each of which corresponds to each data slot of a cycle.
- 2) If an earth station receives a packet sent in a data slot, the response information bit

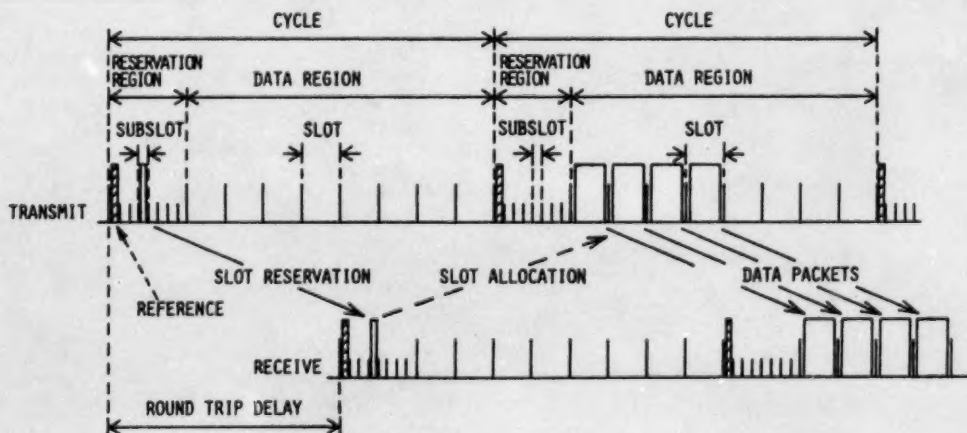


Figure 4. Reservation Scheme

corresponding to that data slot is set to ON, which means the receipt of that packet. Otherwise, this bit is set to OFF.

- 3) Each earth station receives response informations of all earth stations.
- 4) A sending earth station checks the response information from a receiving station. If the response information bit corresponding to the data slot in which the packet was sent is ON, this station knows successful receipt of that packet. If this bit is OFF, this station retransmits that packet.

4.3 TRANSPORT PROTOCOL

- 1) An example of the error recovery sequence is illustrated in Figure 5. A message is segmented into fixed sized packets and the packets are sequentially numbered. One timer T1 is associated with each packet. When the sender transmits a packet which requires acknowledgement, it starts timer T1.
- 2) Receiving a packet, the receiver sends acknowledgement. The acknowledgement consists of the credit and the sequence number T(R) of the next packet the receiver expects to receive. The credit indicates the number of packets the receiver is ready to receive. T(R) acknowledges the receipt of all packets with the sequence number less than it.
- 3) A received packet is held until every other packet of the same message has been received. The packets received out of sequence must be held until the lost packets are also received. Duplicated packets are detected by means of the sequence number and discarded.

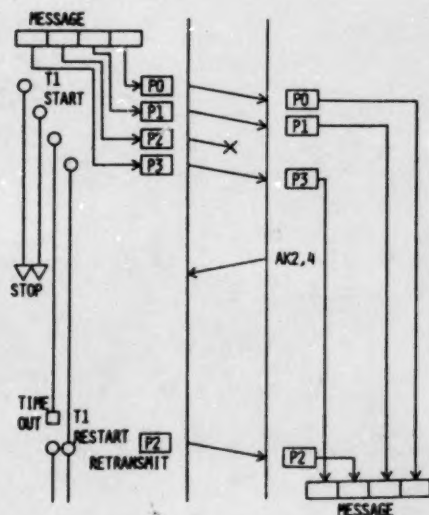


Figure 5. Transport Protocol

- 4) Receiving the acknowledgement, the sender of the packets stops the timer T1 associated with the acknowledgement and sets the lower window edge to T(R). The upper window edge is calculated by adding the value of the credit to the lower window edge. The sender is authorized to send packets with the sequence numbers up to but not including the upper window edge.
- 5) When the timer T1 expires, the associated packet is retransmitted, and the timer T1 is restarted for all subsequent packets.
- 6) When all packets of the message are received, they are delivered to the upper layer.
- 7) To reduce the overhead of the acknowledgements, interval is provided between the receipt of a packet and the transmission of its acknowledgement. All packets received in this interval are acknowledged together.

4.4 SIMULATION CONDITIONS

The simulation is performed on the following conditions.

- o number of earth stations : 7
- o round trip delay : 7 slots
- o number of transport connections in each earth station : 2
- o maximum interval between receipt of a packet and transmission of its acknowledgement : 50 slots

5. THE RESULTS OF THE SIMULATION

5.1 THE PACKET LOST RATE

In the reservation scheme, data slots are allocated by means of the distributed control. When an earth station fails to receive part of reservations because of the transmission error, the allocation of data slots at that earth station is not consistent with others and the collision of packets may occur. Therefore, the packet lost rate becomes larger than the packet transmission error rate. Figure 6 shows the relation between the total traffic and the packet lost rate. It is revealed out that as the total traffic increases, the packet lost rate increases because of the collision of packets. In the following, the packet transmission error rate is given, but it should be noted that the packet lost rate is larger than this error rate.

5.2 THE PERFORMANCE OF THE TRANSPORT PROTOCOL

Figure 7 shows the average message delay versus throughput for the case where the packet transmission error rate is 1 percent, the message length is 1 packet, and the retransmission is not performed in the DL. It is revealed out that the performance of the transport protocol is affected by the value of the timer T1 watch-

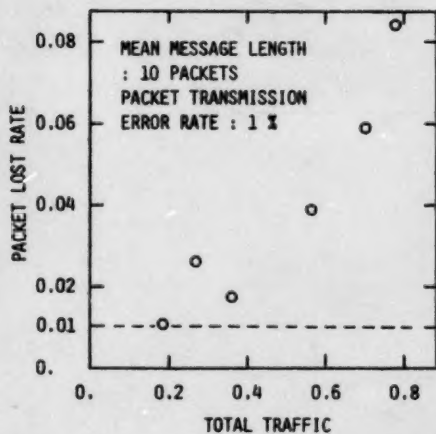


Figure 6. Packet Lost Rate vs. Total Traffic

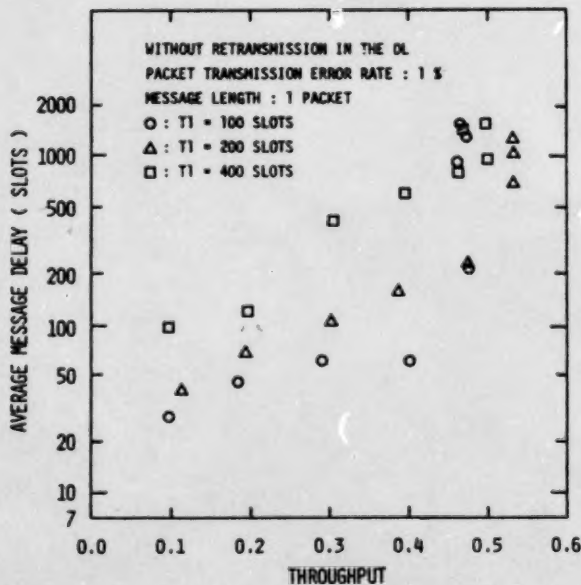


Figure 7. Average Message Delay vs. Throughput

ing the acknowledgement. When the timer value is small, the error recovery is carried out rapidly, and the message delay becomes small. But as the traffic increases and the packet delay becomes large, the duplicated packets due to invalid time out increase and the maximum throughput is suppressed. On the other hand, if the timer value is large, it takes long time to recover lost packets, so the message delay becomes large. Figure 8 shows the traffic versus throughput. Nearly 50 percent of a satellite channel capacity is used as the maximum throughput. Nearly 30 percent is wasted in the retransmission of packets, the duplication of

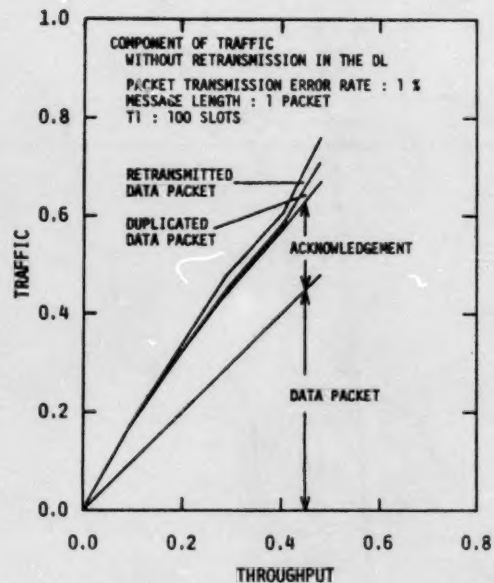


Figure 8. Traffic vs. Throughput

packets, and the transmission of acknowledgements. And the reservation scheme consumes 20 percent of satellite channel capacity for sending the reservations. Since the message length is small, the overhead due to the acknowledgements is large. However when the traffic increases, this overhead relatively decreases because of the collective acknowledgement.

5.3 THE EFFECT OF THE RETRANSMISSION IN THE DL

Figure 9 shows the average message delay versus throughput for the case where the packet transmission error rate is 1 percent, message length is 1 packet, and the retransmission is performed in the DL. It is clear that the message delay is reduced and the effect of the timer value becomes small. This reason is that the retransmission of the lost packet is rapidly carried out in the DL. Figure 10 shows the traffic versus throughput. There are the duplication of packets and the retransmission of acknowledgements which are not necessarily required. But it is clear that these overhead due to the retransmission in the connectionless DL is relatively small.

5.4 IN CASE OF THE LARGE PACKET TRANSMISSION ERROR RATE

Figure 11 shows the average message delay versus throughput for the case where the packet transmission error rate is 5 percent and the message length is 1 packet. In this figure both cases where the retransmission is performed in the DL or not are plotted. When the packet transmission error rate is large, the improvement due to the retransmission in the DL becomes significant.

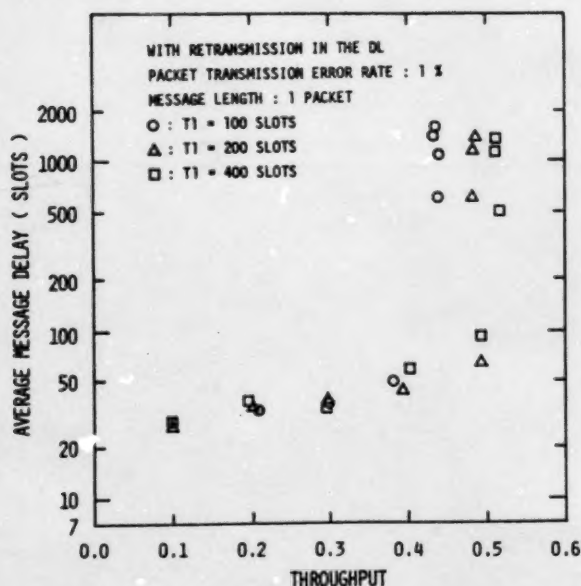


Figure 9. Average Message Delay vs. Throughput

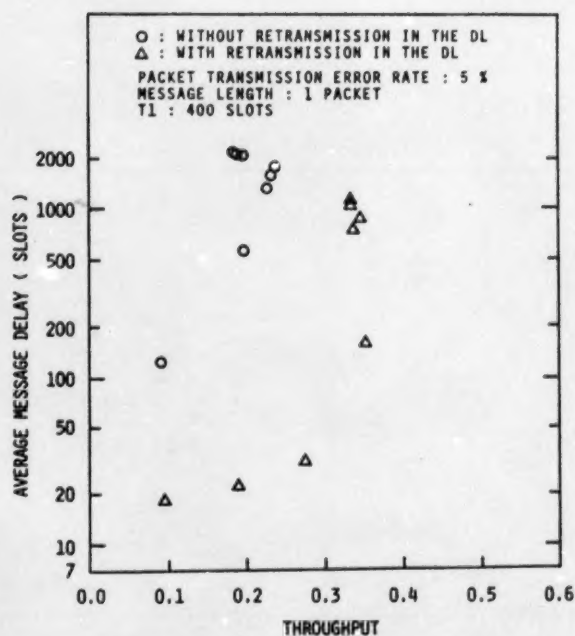


Figure 11. Average Message Delay vs. Throughput

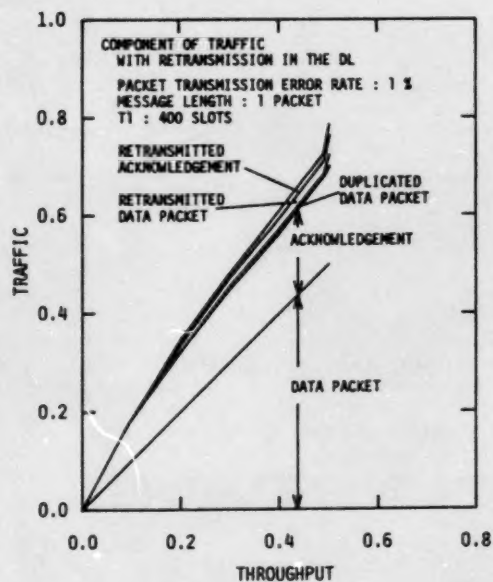


Figure 10. Traffic vs. Throughput

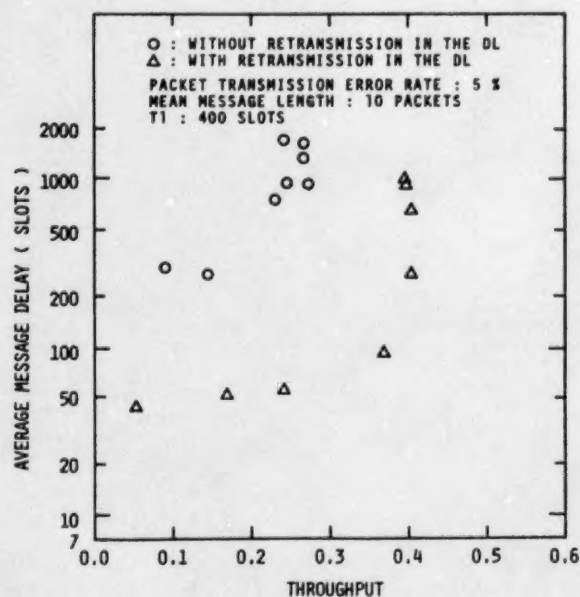


Figure 12. Average Message Delay vs. Throughput

5.5 IN CASE OF THE LONG MESSAGE

Figure 12 shows the average message delay versus throughput for the case where the packet transmission error rate is 5 percent and the mean message length is 10 packets. As the mean message length increases, it is apparent that the maximum throughput increases because of the collective acknowledgement.

As described above, it is revealed out that the overhead due to the retransmission in the connectionless DL is small. And by this retransmission the excellent performance can be obtained even when the packet transmission error rate is large.

6. CONCLUSIONS

In this paper, the relation between the layer model and error control for the satellite computer network was discussed in accordance with the ISO Reference Model. We proposed the location of the layer functions, where the multiple-access, error detection, and retransmission are performed in the connectionless DL, and the error recovery, sequencing, and flow control are performed in the connection-oriented TL. To evaluate the performance of this proposed scheme, the simulation was performed on the model using the reservation scheme in the DL and the protocol corresponding to the ISO class 4 in the TL. By this simulation, it is revealed out that the proposed scheme has the small overhead and the network delay is improved by the retransmission in the connectionless DL. It is cleared that the connectionless-data-transmission is effective for the satellite communications, and that the satellite computer networks achieving the high performance can be constructed by using the proposed scheme in accordance with the trend of the standardization of the ISO.

ACKNOWLEDGEMENT

The authors would like to thank for Dr. T. Saito of the University of Tokyo for his many valuable suggestions.

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Videotex Service in Japan
CAPTAIN System

Mitsunori Kawasaki
Nippon Telegraph & Telephone
Public Corporation
Tokyo Japan

1. Abstract

The CAPTAIN (Character And Pattern Telephone Access Information Network) system is an interactive videotex system developed in Japan. The second stage trial service has been carried out since August 1981 after the first stage trial was started in December 1979. The distinguishing features of the second stage trial are that new services have been introduced, such as a closed user group service and an order entry service. In addition some other system functions have been enhanced. Commercial service for the CAPTAIN is scheduled to start in the metropolitan Tokyo area in 1983. This paper describes the CAPTAIN system, the present status of the second stage trial service, and the future of the CAPTAIN system.

2. INTRODUCTION

A number of visual information media have been developed and trial services are being carried out either in community areas or in-house basis in Japan. Among them, the CAPTAIN system is a new video communications medium so that everyone may be able to interact directly with computer-based information sources from their homes or offices, anytime anywhere at a low cost.

In April 1978, the Ministry of Posts and Telecommunications announced the CAPTAIN system plan, the Nippon Telegraph & Telephone Public Corporation (NTT) developed the CAPTAIN system for the first videotex field trial in Japan. The first stage trial service was conducted in the metropolitan Tokyo area from December 1979 to March 1981 with a storage capacity of 100,000 frames provided in the center, and with 1,000 user terminals installed on the premises of the monitors and information providers.

Based on the evaluation of the first stage trial, the second stage trial service with several enhanced functions was commenced in August 1981 for commercial use in 1983.

- (1) Editing Unit used for communication control and editing frames of information from user terminals was installed in the center.
- (2) Editing terminals have been introduced that permit information providers to input data from their premises.
- (3) Information input terminals with TV camera, and information input terminals with kana-kanji conversion function have been installed at the center.
- (4) Hard copy units have been installed for optional connection to the terminals.
- (5) Mnemonic retrieval with kana/alphanumeric keypad on user terminals.

- (6) The following new service functions have been introduced.

- 1) Order entry service
- 2) Closed user group service

The outline of the CAPTAIN system is as follows.

3. OUTLINE OF THE CAPTAIN SYSTEM

The CAPTAIN system consists of an image conversion center, an information center, information input terminals and user terminals as illustrated in Figure 1.

3.1 CENTER

The image conversion center, equipped with the character generator, converts the retrieved information data into dotted patterns suitable for display on the screens at user terminals.

The information center serves mainly for information storing and retrieval.

The existing public telephone network is used as the transmission line between user terminals and the center, with 3200 bits/second full duplex transmission rate from the center to user terminals and 75 bits/second in the opposite direction in this stage.

3.2 INFORMATION INPUT TERMINALS

As to information input terminals, there are four types of information input terminals through which data can be input to the center.

- (1) The IT-A is a tablet type information input terminal used to input kanji, kana, alphanumeric and mosaic symbols.
- (2) The IT-B is a facsimile type information input terminal which handles hand-written patterns in addition to those given to the IT-A.

The following two types were made as second stage improvement.

- (3) The IT-C has a kana-kanji conversion function with a kana and alphanumeric keyboard.
- (4) The IT-D is a camera type input terminal which permits the same input of mosaic symbols, photographs, and hand-written pictures as IT-B.
The most important advantage of the unit is that the enlargement, reduction, and translation functions of patterns are provided in addition to the function for IT-B.

3.3 USER TERMINALS

There are three types of terminals manufactured by seven firms available: an adapter type, a built-in type and an editing type.

(1) Adapter type

The adapter placed on the TV set at the user's house converts dotted pattern information signals transmitted from the center into signals suitable for the television screen. With a wireless control keypad, the user can gain access to information easily.

(2) Built-in type

The built-in type is a terminal dedicated to CAPTAIN which incorporates the function of an adapter and a small sized CRT, which is suited for users to make frequent use of CAPTAIN.

(3) Editing type

The editing terminal, which is used for the creation and editing of frames of information with easy operation at a reasonable cost from the information provider's premises, is equipped with the adapter, keyboard, and CRT in a single enclosure. This features the kana-kanji conversion and editing functions by means of the on-line processing through the public telephone network.

3.4 TRANSMISSION METHOD

CAPTAIN is similar to other videotex systems such as British PRESTEL, German BILDschirmTEXT, French TELETEL, Canadian TELIDON, and the like, the primary difference being the transmission method. The CAPTAIN system employs the pattern transmission method in order to display structurally complex characters such as more than 3,000 kanji characters, kana in addition to alphanumerics. As this method not only offers the advantage of displaying kanji characters but makes it possible to display hand-drawn pictures and photographs, it can be said that it is the only technique superior

to the code transmission method.

As to the frame forming time, the pattern transmission requires a slightly longer time in comparison with a code transmission rate.

At present, CAPTAIN forms a frame on the screen within eight seconds on the average to achieve sufficient practical use. However, for further improvement of frame forming time, the hybrid transmission method was developed as described below.

3.5 HARD COPY UNIT

Hard copy units have been introduced that can record images on the screen by electrically burning an impression on the paper. This unit is capable of printing the area of one frame in five seconds.

4. PRESENT STATUS OF THE SECOND STAGE TRIAL

4.1 NUMBER OF MONITOR TERMINALS

Monitors have been selected from people living in the metropolitan Tokyo area.

The number of monitor terminals is as follows:

Residence	1,200
Office	500
Information provider ..	200
Demonstration	100
Total	2,000

4.2 INFORMATION PROVIDERS (IPs)

Two hundred and thirty one organizations are participating in the trial service and cooperating as information providers. These information providers (IPs) have organized the Association of CAPTAIN Experimental Information Providers of which the main function is to consider problems related to providing information for the improvement of system software and functions.

Information providers are classified by industry as follows:

Publisher.....	33
Advertisement agency	23
Newspaper	26
Department store	21
Travel agency	20
Research & consultant	18
Broadcasting	9
Bank/Insurance	35
Commerce/Trade	17
Public Corp/Others	29
Total	231

4.3 INFORMATION CATEGORIES AND NUMBER OF FRAMES

The CAPTAIN database has a capacity of 200,000 frames. At present, there are around 187,000 frames in use, which are categorized as follows;

	Share of frame (%)
News & Weather Reports	7.3
Public Information	6.7
Health & Beauty	0.7
Shopping Guides	3.0
Cooking	3.6
Housing & Real Estate	2.8
Home Economics & Law	1.4
General Knowledge for Living	6.1
Education & Culture	15.6
Sports	8.2
Amusements & Hobbies ...	21.4
Travel & Sight-seeing	4.5
Business Information	7.6
Information in English	0.6
Town Guides	0.4
Others	10.1
Total	100.0
(As of November 1)	

4.4 RETRIEVAL METHODS

The CAPTAIN system provides users with the following five methods of information retrieval.

(1) Retrieval by index frame

This method of accessing information, through a tree-structured search technique, is one in which the users select one of the major categories from an index page on the screen and narrow down their search by choosing from successive menus by means of a simple numeric keypad.

(2) Retrieval by page number

With this method, users may request the desired information by designating the appropriate page number assigned to it in the CAPTAIN directory.

(3) Retrieval by mnemonics

To obtain a desired index page by an easier procedure, mnemonics, listing the information categories such as news, sports, shopping, etc., have been specified for the corresponding index pages.

As an example, a user might initially input "NEWS" as the character string by using the kana/alphanumeric keypad and follow successive branches in the tree-structured search technique to obtain information on news provided by the IPs of interest.

(4) Retrieval by two digits

It is possible to register the page number of the information frame displayed on the screen as a corresponding two digit number. To achieve this function, the following commands are provided.

Command for registration: O*NN# (NN: 00-19)

Command for retrieval : *NN# (NN: 00-19)

The registration is effective even after turning off the terminal until another page number is registered as the same two digit number.

(5) Retrieval by page number

The page number displayed on the screen can be memorized at the center temporarily with a maximum of five pages by pushing the asterisk (*) key and MEMORY key sequentially. Then, the memorized page is retrieved immediately after pushing the MEMORY button. Memorization is only effective during that session and is cleared off when the terminal is disconnected.

4.5 ENHANCED SERVICE

In addition to information retrieval service, new services such as an order entry service and a closed user group service are introduced.

(1) Order entry service

This service permits users to order goods such as books, records and household electrical appliances in accordance with a guide displayed. At present, the following services are available.

- Home shopping
- Participating in price quizzes
- Replying to questionnaires
- Requesting for brochures
- Sending complaints and compliments

(2) Closed user group service

Through closed user group service (C.U.G), information providers may make their frames available only to restricted users belonging to this service.

At present, there are 13 closed user groups to disseminate their internal information to 400 members on a subscription basis.

4.6 INFORMATION INPUT

(1) At the center

There are 17 input terminals which can input about 1,000 frames a day. It takes six or more minutes to build up one frame.

(2) Editing terminal (ET)

The actual condition of usage of editing terminals installed on IPs' premises is that the share of total frames in center is about 31%.

4.7 USAGE OF TERMINALS

The actual conditions of usage of user terminals

are shown below.

Average frequency
per terminal per day 0.88
Average holding time
occupied per call 11 minutes
and 36 seconds
Average number of frames
used per call 38

4.8 SYSTEM OPERATION

The service time for monitors is from 10 a.m. to 10 p.m., seven days a week. The editing terminals are available for 12 hours of service, from 9 a.m. to 9 p.m., every day.

5. EVALUATION BY MONITORS

This section presents the results of a questionnaire reflecting the opinions of the monitors of the system.

5.1 USEFUL INFORMATION

The following categories are appraised as useful information.

Residential	1. Weather Reports
	2. Cinema Guides
	3. Cooking
	4. Gallery and Museum Guides
Business	5. Educational Programs
	1. Weather Reports
	2. News
	3. Exhibition & Seminar Guides
	4. Train & plane time-tables
	5. Stock market & Exchange rate

5.2 ENRICHMENT AND NEW ITEMS OF INFORMATION

The following categories are being required to be enhanced or supplemented.

Residential	1. Road traffic information
	2. Stock market
	3. Seat reservation for trains and planes
	4. Weather Reports
	5. Community information
Business	1. Road traffic information
	2. Stock market
	3. New products & Technical Information
	4. Exchange rates
	5. Yellow pages

5.3 DESIRE FOR IMPROVEMENT IN THE SYSTEM

Monitors expressed desires of improved services in the following areas.

- Substantiality of information
- Extension of service hours
- Indication of incoming calls
- Improvement on the operation of a terminal
- Audio-visual terminals

Furthermore, monitors require the following new services through the CAPTAIN.

- 1) Reservation for train
- 2) Reservation for hotel
- 3) Reservation for theater
- 4) Account information balance
- 5) Person to person communication
- 6) Data processing
- 7) Prompt access to stock market

5.4 INFORMATION CHARGE

During the trial service, information is provided free of charge to monitors by IPs' whose only expense is the local telephone charge (V10=0.0465\$/3 minutes).

More than 50% of the monitors are willing to use this system as commercial service. With regard to the charge applied to the service, the majority of the monitors expressed a willingness to pay about V3,000 (\$13) per month. 20% of them are willing to pay more than V3,000.

6. FUTURE OF CAPTAIN

The CAPTAIN system could have an immense impact on the national life as an economical visual communications service using an existing telephone and a regular television set already installed. It offers not only an information retrieval service, but widespread service capable of home shopping and home banking by connecting it to various external computers.

The following are the terms required for increasing the systems penetration.

- Development of user terminals
- Enhancement of information, enlargement of application fields
- Offering services at an inexpensive price

It seems to be important, particularly in the initial stage of commencing the service, to realize these conditions. Taking the above conditions into account, we are making an effort to implement the commercial service scheduled for the end of fiscal 1983.

6.1 GATEWAY CONNECTION IN EXTERNAL COMPUTER

Videotex service is subdivided into an information retrieval service and a transactional service. The CAPTAIN has already enabled users to order commodities and request brochures through the order entry service from their home. However, this service has room for improvement because of indirect connection between customers and IPs. As to the information retrieval service, the information file is managed solely by the center in the

present situation.

To overcome these problems and offer various transactional service such as home shopping, home banking, and reservation service, the methods of implementing gateway connections are being studied. At present, interconnection with stock market database and airline seat database is under consideration.

6.2 HYBRID TRANSMISSION

The hybrid transmission method consisting of the pattern transmission and the code transmission has been studied by NTT for substantial reductions in frame forming time.

With the development of the semiconductor memory, an economical character generator has been realized. Applying it to a user terminal, the hybrid transmission method in which characters such as kanji, kana, and alphanumerics can be transmitted in coded form, and hand-written graphics in dotted pattern form, is the new technique adaptable to existing high graphic capability. Based on this method, the user terminals with a capacity of about a one megabit character generator containing 3,000 kanji have been made for experimental purposes.

Sufficient results have been obtained. Depending on the ratio of hand written graphics to a frame, it was found that this method can form a frame for display in about one second and has the additional advantage of reducing a frame forming time in addition to the wide variety of display capabilities.

Furthermore, this method seems to be applicable to interchanging information with countries using coded-videotex systems internationally in the future.

In commercial service, two kinds of user terminals based on pattern transmission and hybrid transmission may be supplied by manufacturers on the market.

6.3 COEXISTENCE OF A HYBRID TERMINAL AND A CONVENTIONAL TERMINAL

Two kinds of terminals, corresponding to the pattern transmission and the code transmission methods, will be furnished on the market by manufacturers. As far as a hybrid terminal is concerned, we anticipate that the cost of a terminal will be a little bit more expensive than a conventional terminal but will penetrate into business because of quick frame forming time.

6.4 IMPROVEMENT OF THE TRANSMISSION RATE

The 4800 bits/second and 75 bits/second full duplex transmission rate will be applicable for the commercial service.

6.5 NETWORK CONFIGURATION

The videotex network, offering the CAPTAIN service provided by NTT, would connect a large number of

terminals with the computer system and embody general visual communications services prevailing throughout the country in the future. Functions of the network and terminal will be shared appropriately and a similar flat charge will be levied all over the country.

6.5 USER TERMINALS

In order to provide a wide range of terminals which meet user needs and fancy, we are making it a principle that manufacturers supply user terminals, and that users each choose their own terminal.

6.7 SHARED CENTER

For the information providers offering information without the use of their own computers, a shared information center may be established.

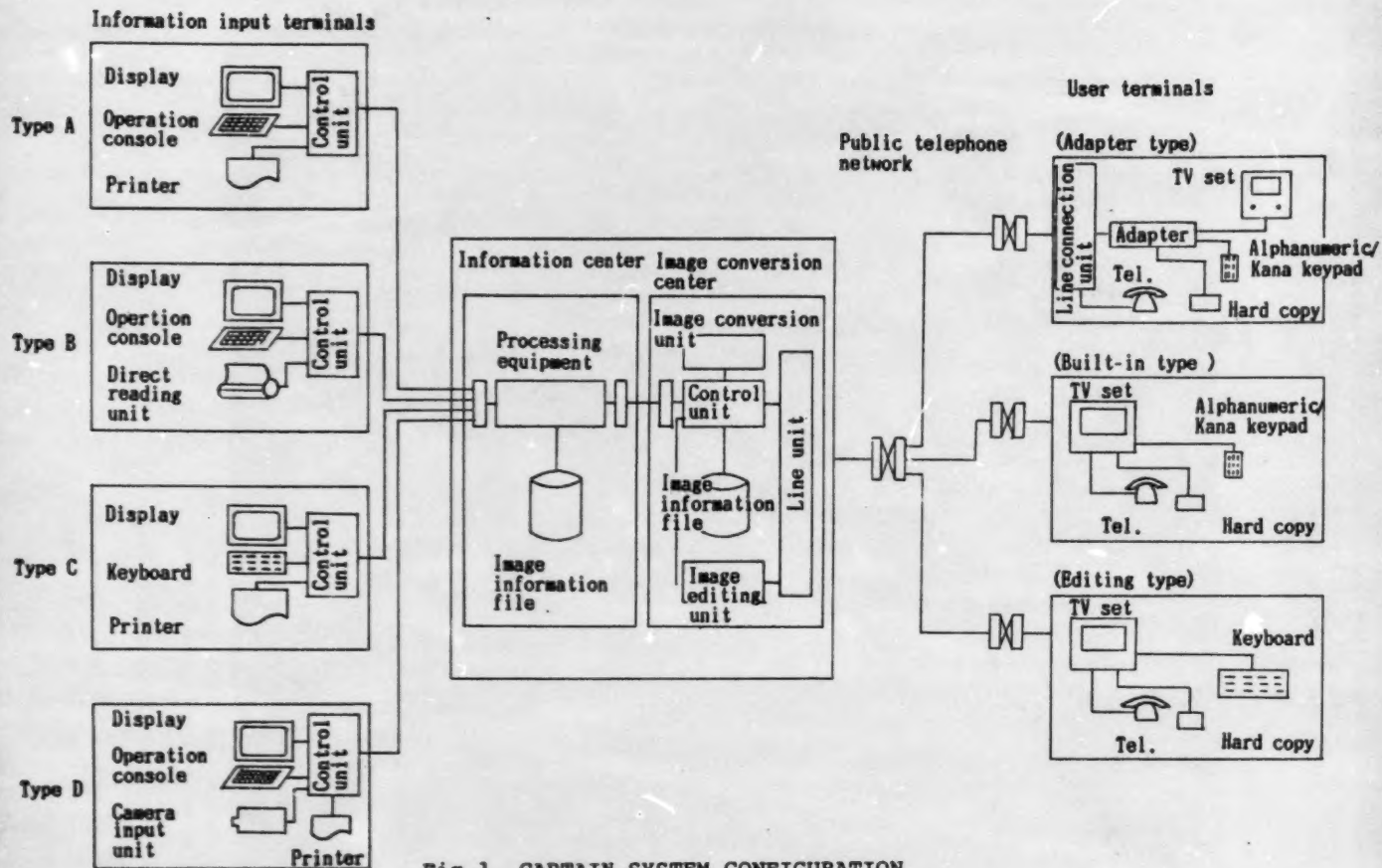


Fig.1 CAPTAIN SYSTEM CONFIGURATION

George Van Valkenburg
President
QUICKSCAN Systems, Ltd. (USA)
9465 Wilshire Boulevard
Beverly Hills, CA 90212
(213) 841-6750

Abstract

Because QUICKSCAN electronic publishing exploits the widely-available global television infrastructure, it can transmit up to 1800 pages per minute of photographic-quality images, graphics and text to videocassette recorders for later readout. It requires no new technical standards, no hardware modification at the user's end, and has several subtle advantages over narrowband systems. The system is scheduled for first market test in 1983 and promises to claim its niche in the emerging Information Society.

QUICKSCAN-indexed video electronic publishing is a new addition to the ranks of electronic information dissemination and retrieval methods. It is possibly the first practical system of delivering high volume text and image via broadband networks for local search and readout.

It has distinctive roots in the past two Pacific Telecommunications Conferences, and may be considered a byproduct of NETWORK NEW ZEALAND, a study published in 1981 by the New Zealand Commission for the Future.

A fundamental conclusion of NETWORK NEW ZEALAND was that the future will be bandwidth-abundant. Optical fibers, direct broadcasting satellites, low-power television systems, and other frequency multiplication techniques can ensure that, for most of the globe, the days of bandwidth shortage are over.

Some important implications derive from this assertion. For one, it means that many of the regulations based on an allocation of scarce spectrum resources can be relaxed or eliminated.

For another, it means that methodologies, including teletext and videotex, which are designed to squeeze the last ounce of use out of narrowband networks such as the twisted copper pair, are in for a reduced share of their perceived market.

As a member of the Communications Policy Research Group responsible for the New Zealand study, I came to some additional insights as an individual.

First, The Future is Now! The global telephone network has evolved over a long period of time, and when paired with a computer-type terminal, extends two-way communications into the Information Age. Similarly, the global broadband network which is the television infrastructure, when paired with a capture and readout device such as a videocassette recorder, can extend one-way communications, or Electronic Publishing into the Information Age.

Historically, television has been applied largely to entertainment and more or less trivial applications. Looked at as a broadband communications network, capable of transmitting thousands of screens of information per minute, it is a resource of staggering potential.

My second personal insight was that the missing link between today's television state-of-the-art and tomorrow's electronic publishing service was very small, and elegantly simple.

I took on the task of inventing that link, and by January 1982 QUICKSCAN was a demonstrable reality. At the 1982 PTC it was presented privately to some knowledgeable individuals, although our stage of development did not permit public display. Their response in general was overwhelmingly positive, and reinforced the opinion that it truly represented an addition to the state-of-the-art.

At this point, observers may question the validity of a one-way or mass media flow of information for future applications. The conventional wisdom has been

that two-way communications are inherently superior and the hallmark of the Information age.

The answer depends largely on the application. Two-way links are necessary and appropriate for electronic mail, which may be thought of as a slow-motion telephone conversation. Two-way communications are also necessary when the user is inputting information or data, or in any way manipulating the data remotely, such as in a transaction.

But for applications dealing generally with information dissemination and retrieval, both one-way and two-way media compete. In computer terms, there are tradeoffs between on-line search of a remote database, and batch delivery of the complete database for local search and retrieval. That, in essence, is where QUICKSCAN finds its niche.

Publishing and broadcasting historically have been one-way flows of professionally prepared and packaged information from a single source to many users or readers. The need for such flows will not cease in the Information Age. The immediacy of electronic access and reduction of cost may in fact increase their importance in the marketplace.

The relationship between PTC and QUICKSCAN development actually goes back to 1981. At that time I presented a paper titled "A Futurist Looks at Telecommunications." In retrospect, it delineated some of the shortcomings of narrowband services without postulating an answer. It questioned the quality of image and graphic presentation; the total cost of connection and usage; the difficulty in attracting advertising support, and the complexity of use for those of us who are not truly computer literate.

The simple answer to all of the above limitations turns out to be a matter of converting ordinary raster-scan frames of video into retrievable pages of text, graphics and pictures, batch delivered at rates compatible with the frame frequency of the television standard involved, and captured and read out on an unmodified videocassette recorder or similar device. No new technical standards are required, and very little new hardware is necessary at the head end.

This means that NTSC systems have a maximum transmission rate of 1800 frames or pages per minute, while PAL can transmit up to 1500 pages per minute. The proprietary QUICKSCAN-indexing method permits any of those frames or

pages to be located easily and retrieved for readout on a television screen. At the user's end, certain currently available off-the-shelf home VCRs have the necessary qualities of still-frame and stepping to access the contents of the video publications. There is no keyboard or keypad involved in the initial level of QUICKSCAN electronic publishing, therefore a major barrier for many users is eliminated.

There are a number of subtle advantages inherent in the QUICKSCAN method. For example, since the display is a raster-scanned image instead of a digitally encoded reconstruction, it can interchangeably display English, Japanese, Arabic, or any other method of visual communication including ancient hieroglyphics, and transmit each page in 1/25th or a second or less.

Also, the failure modes of encoded and scanned systems are completely different. If for any reason, an error creeps through a digital system despite correction techniques, it may end up on the screen as a perfectly legible but erroneous letter or number. Thus, a system failure can deliver incorrect information, a fatal flaw when dealing with financial data. Such problems have been reported in the press in connection with early Australian teletext experiments.

In contrast, in a television field or frame, each letter or number is the product of many pixels of information. If the display degrades to the extent that it cannot be read clearly, the user knows that he does not know. In this sense, the analog display is "fail-safe". The user will look to a second source for the data rather than act on erroneous information.

Another inherent advantage relates to the sequential scanning nature of retrieval of pages of information from a videotape. Because during visual search for information in the QUICKSCAN method the user is exposed to all of the intervening pages, it suggests that this service can be advertiser supported. It becomes a true electronic analog to the familiar newspaper or magazine, which derives revenue from the sale of ads which will be seen by readers looking for the surrounding editorial material.

In a random access retrieval system, the user sees only those pages he requests. He is never exposed to an advertiser's message unless it appears on the page he calls up. This characteristic, plus the

limited quality of graphics deliverable by narrowband systems in a reasonable timeframe, indicates that persuasive advertising is difficult to sell in such a system.

QUICKSCAN maintains the "editorial" function in electronic publishing because the juxtaposition of editorial content and full page photographic quality ads can be structured much as in print media. Virtually all of the techniques developed over the years to enhance the impact of print advertising can be directly transposed to the screen.

If desired, live action sequences can be interspersed with the compressed still-frame "datapacks" much as in a videodisc presentation. Therefore, a QUICKSCAN publication has many of the characteristics of a recording videodisc presentation.

The amenability to advertising revenue support, plus the very rapid delivery rate, imply basic changes in the user's cost of accessing electronically delivered information. If the information provider chooses, he can literally give away his editorial material like the 6 o'clock television news, if he wants to be completely advertiser-supported.

Compare the twin revenue streams of the conventional magazine -- advertising and subscription charges -- and then compare the cost of information content vs. the costs of production and delivery. The potential tradeoff becomes evident. In a QUICKSCAN publication, the creative tasks remain: writing, photography, editorial, makeup. The costs of production and delivery approach the vanishing point, and remain the same for a user population of 100 or 100,000,000. Paper, ink, printing, postage, physical delivery -- all are replaced by a single video origination facility.

Therefore, if the information provider so chooses, the user can be freed from subscription costs, telephone line costs and page charges. His responsibility and cost begin and end with the purchase or rental of an appropriate VCR and television screen, plus the cost of a few cassettes, which can be recycled an indefinite number of times.

Of course, in the case of a subscription television system or pay-cable service, QUICKSCAN electronic publishing can be partially or totally subscription based.

This year, 1983, will see first market tests of QUICKSCAN, both in Australia

and the United States. It was announced in October 1982 that Television Australia-Satellite System plan to conduct trials of the method via quasi-direct broadcasting satellite service and local retransmitters to bring electronic publishing to the Australian outback.

In November 1982 it was announced that Dow Jones & Company had become a QUICKSCAN licensee and would explore the delivery of Dow Jones Information Services in the QUICKSCAN format.

The future state-of-the art of global television promises to favor even more advanced modes of QUICKSCAN electronic publishing. High definition TV will permit more information per page, and presages the time when a screen "page" may be the one-to-one equivalent of a magazine page. Digital television standards will improve the quality and reliability of received signals. Improved VCRs, dedicated VCRs and other capture and readout devices will add to the inherent ease of access of the medium.

Looking backwards, we can date the Age of Electronic Information to Morse code and "Dr. Watson". Looking forward we are only a few months from George Orwell's vision, with all of its threats and promises. This World Communications Year marks a convenient watershed between that known past and that unpredictable future. If, as has been suggested here, the future becomes more and more broadband oriented, then QUICKSCAN electronic publishing promises to become a major contender in the global marketplace.

From the Information Society
to the Communication Society (1)

Jean P. Voge
Institut pour le Développement et l'Aménagement
des Télécommunications et de l'Economie
Montpellier (France)

1. Abstract

The economic growth has led to an information society in crisis. The centralized structures built during the industrial era are economically and socially inadequate to the complexity of human communications, which are blocked or reduced to a simple monologue. The only hope for re-establishing a dialogue and overcoming this crisis (by minimizing the costs of organization) lies in the emergence of a new society which, fostered by socioeconomic pressures with the aid of computer and communication technologies, will be a decentralized communication society, made up of semi-autonomous, convivial, yet interdependent micro-societies.

2.1 INTRODUCTION

It takes just one millionth of a second for an administration's computer to process a piece of information, but in the meantime the files it must handle pile up on desks for months on end. In telephony, an entirely automatic link can be set up between any two points on the globe via satellite in only a few seconds, but three times out of four, or nine times out of ten for high level management, the correspondent, near or far, is absent or busy, and no one is capable of answering on his behalf. There has never been such a multiplicity of information transmitting media, and yet it has never been so difficult to obtain the information desired or needed to solve a problem. Even in spite of numerous polls and great technical advances, communications tend to break down between businesses and their customers, public services and users, and more generally between individuals, social groups, and nations. As a last resort, shouts and violence are employed to transmit messages to those to whom are addressed.

The situation is every bit as contradictory economically. Information is the only resource which can be reused without being damaged or destroyed. Therefore, in the free market, it should logically be very inexpensive. Unfortunately, this is not the case and, in constant currency, the price of "useful" information aimed at meeting a precise need has risen steadily, at the pace of salary growths. This evolution is certainly prevalent in the academic field, but also applies to any activity linked to a country's economic and social organization: research, information services, administrative, industrial, or business communications and transactions, public and private bureaucraties, and social protection (laws, jurisdiction, negotiation, insurance, etc...). The proportion of these organization and information costs within

the national product and the percentage of white collar workers in the labor force, has grown steadily from 10 % at the beginning of the century to almost 50 % in the U.S. and 40 % in other industrialized countries. When this figure exceeds 50 %, the production of material goods (in agriculture, industry, and construction), representing the nation's tangible wealth, begins to lag, and eventually both production and consumption stagnate. It is therefore not surprising to observe an economic saturation at this 50 % level, already reached in the U.S. and expected to be reached in Europe before the end of this century. Indeed, after a slowdown starting in 1965, U.S. productivity (average product per worker) stopped rising, as did the population's standard of living.

Like the energy crisis, this information crisis has strongly affected developing countries which call upon foreign teachers, technicians, doctors, and experts to aid in the development process. The inflated price of information has clearly been exported to these countries and constitutes a serious obstacle.

What is the cause of this disturbing situation? Undoubtedly, it is due to the diseconomies of scale affecting the information sector, in contrast to the economies of scale realized when material goods are produced in increasing quantities. Thus the task of finding useful information is all the more burdensome as it involves searching among a larger mass of information. By the same token, the search for the right correspondent grows more difficult, as the size of the organization grows. Yet, it is not the volume or size of information or organization but its structure which play the major role: when such structures are centralized and unitary (which is most commonly the case), diseconomies of scale are greatest. Parkinson demonstrated in his "law" that, as a centralized business

or administration expands, the number of bureaucrats grows ; yet the number of messages grows twice as fast, since each person must address all of the others. As a result, internal communications swell to 80 to 90 % of the total volume of communications and the organization ends up cutting itself off from the very people it is supposed to serve. Furthermore, the tops of hierarchical pyramids are notorious bottlenecks for information : while communications flow easily downward, they rarely succeed in reaching the top.

As we begin to grasp these phenomena, possible solutions may be found in decentralization and a new, more efficient, electronic information economy. Yet in order to formulate appropriate policies, we must understand the problems arising from the complexity of modern society. A multidisciplinary approach to the economics of complex systems (of any nature, made up of a large number of interacting elements) can aid our comprehension in this area.

2.2 THE POLITICAL ECONOMICS OF COMPLEXITY

Telephone networks provide an excellent illustration of interactive systems, since they must interconnect any two out of N subscribers without blocking. The number N , depending on the country, may vary from several millions to tens of millions. The network's "economy" is characterized by the number of cross points, either electromechanical relays or electronic contacts, which are needed to ensure all interconnections. A theory was developed, confirming a largely spontaneous evolution, that the most economic systems, in terms of the number of contacts, derive from the structure shown in figure 1. They are multilevel, based on a number N_1 of telephone stations. N_1 corresponds to the size of the elementary connection matrices in the telephone exchange. Generally ranging from 10 to 100 lines, this number is far smaller than the total number N . Each level contains the same number of matrices, whether they are located in the same exchange or in a different one ; each matrix contains the same number N_1 of input lines. This structure is completely decentralized, or "distributed", unlike that in figure 2 which is centralized in a conventional pyramid form made up of subordinate levels. The essential difference between these two structures resides in the capability of the distributed structure to freely select a connection in each node to form an itinerary among N_1 alternatives.

We can establish that the number of contacts is lowest in a distributed structure such as that in figure 1. The theoretical limit is approximately $N_1 N \log N$ (where $\log$ designates a decimal logarithm), whereas this number would be far greater, about N^2 , in a centralized structure. For example, if $N = 1$ million and $N_1 = 10$, the number of contacts in a decentralized structure is reduced by a ratio of $1\,000\,000/60$, or 17,000. This type of gain is also found in the numbering system : by

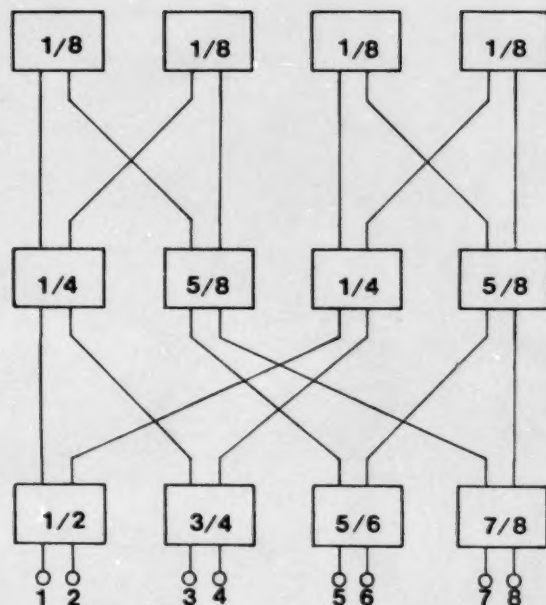


Figure 1 : Distributed telephone network structure ($N_1 = 2$, $N = 8$)

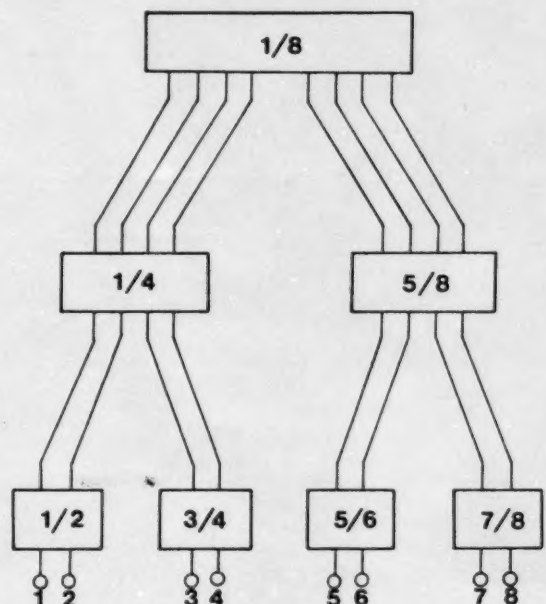


Figure 2 : Centralized telephone network structure ($N_1 = 2$, $N = 8$)

using decimal numbering, one number out of a million can be reached through six successive selections of one out of ten numbers. Thus only 60 possibilities are considered, rather than a million. It is easy to see the advantage of distributing the selection process among several levels rather than maintaining it at the top of pyramidal hierarchies.

It can also be pointed out that contacts in a distributed structure are evenly divided among several levels, while in a centralized structure most contacts are concentrated in the upper levels, just as white collar workers and the bureaucracy are concentrated at the top of political or economic hierarchies.

These observations are true for all natural or man-made systems, when the power expenses (entropic dissipation), or the general organization costs for the interworking of the system's elements are taken into consideration. The shift from a centralized structure to a distributed structure results in the same gain as that found in the telephone network contacts, as described above. This gain also applies to the time needed to build such a system: decentralized structures evolve and adapt to environmental changes far more rapidly.

Not surprisingly, as the 1962 Nobel prizewinner in economics Herbert Simon observed, most natural or artificial systems actually are distributed (2). This is true in physics (elementary particles, atoms, molecules, molecular structures), in astronomy, in biology (macromolecules, cells, tissues, organs), in literature, and in music. At it appears, only formalised socio-political structures are centralized hierarchies, where each subsystem is submitted to the authority of a higher-level system. Can it be concluded that, aside from cases where human authority has intervened, distributed structures, which are the most economic, tend to develop spontaneously?

The most recent theories on self-organization tend to confirm this conclusion. Ilya Prigogine, Nobel prizewinner in chemistry, demonstrated that stable intermediate subsystems form within a system once a critical threshold is reached via processes resembling "nucleation" of crystals or whirlpools in a homogeneous medium (3). The selection process, whether conscious, as in human organization, or natural as shown by Darwin, also plays a major role. At each level, this process intervenes to optimize and differentiate the functional behavior of the various subsystems, and to prepare the nucleation of the higher-level systems. Another Nobel prizewinner in chemistry, Manfred Eigen, clearly showed, in a study on the origin of life, that this progressive building takes place from one level to the next in biology: macromolecules, cells, multicellular organisms (4). This type of

evolution appears logical to the human brain which, itself, proceeds in a similar fashion when it gathers knowledge or searches for the solution to a problem. The process involves an alternating sequence of analysis (selection) and synthesis (nucleation) as the solution gradually takes shape (5).

To conclude, any complex system's economy requires a balanced and fair distribution of autonomy (selection and differentiation) and solidarity (nucleation of subsystems) among its various organizational levels. Curiously enough, the key words of this economy are the same as those in the motto of the French Republic: liberty, equality, fraternity. Yet unfortunately, in most socioeconomic organizations, and especially in France, Napoleonic concepts of centralization appear to dominate, whether in the power structure (NationState) or in solidarity (Welfare State).

2.3 THE MEANS AND THE RIGHT TO COMMUNICATE

The analogy I have attempted to make between the economy of communications and the economy of a complex system's interactions has emphasized the urgent need to distribute the organizational structures of human society more equitably. As mentioned, these structures must, for the most part, develop spontaneously from the base. This evolutionary tendency is beginning to show today in the depths of a society which is seriously afflicted by the economic crisis. Challenging the political penchant for overcentralization, micro-societies are springing up all around us. Undoubtedly, as the sociologist Daniel BELL noted, this is because "the Nation-State has grown too big to handle life's little problems".

In France, in 1980, 25,000 associations were created, while in 1965, this figure was 7 000. Religious sects are proliferating at a somewhat disturbing pace. We are also witnessing a new development of local interactive communication networks based on cable, radio links, or optical fiber. Although they are still in an anarchic infancy stage, these networks hold great promise for low costs, since voice, text, or moving image signals will not require reamplification. By providing a new human-scale form of conviviality among members of local groups or work communities, these networks will revive the concept of the forum, the common ground for business transactions, shows, public affairs, trade, justice, and religious activities. The electronic channel is not likely to "de-humanize" communications between people who already know each other, meet frequently, and share the same lifestyle. Furthermore, these networks will contain a storage memory and sufficient capacity for information processing to allow a high degree of independence in responsibility and decision-making.

Selection is the key process in determining the economy and productivity of a distributed structure. This is true for the interface between a local network and the outside world (other local networks and higher-level organizations). While the "telematic" inter-connection network is non-negligible, human operators are the main actors in the selection process, which first entails the filtering of parasitic information and reducing exchanged data or messages to their essential elements. This selection prevents the transmission of useless or purely local information towards central memories, where it would only pollute and saturate those arteries which should be reserved for information of regional or national interest. Communication pyramids could be flattened by multiplying the number of spokesmen able to respond on behalf of higher authorities. Yet more importantly, people will increasingly call upon human middlemen who, like today's travel agency employees, work skillfully with highly versatile terminals. These "telemediators" will often be indispensable for quickly finding the right information or correspondent, and also for ensuring that messages are correctly interpreted, and for encouraging human transaction, solidarity, or consensus-building.

Typical examples of such mediators may include city hall or post office workers in decentralized communities who aid the public with a global and integrated approach to all local, regional, or national administrative services. Utilizing electronic means, they would play a role similar to that of the public scribe, whose profession died out with the spread of literacy, but whose services are reappearing, as administrative procedures become more and more complex. By the same token, family notaries and doctors, both a "dying species" of general practitioners due to the proliferation of specialists and specialized institutions (laboratories, banks, financial or real estate, investment companies, insurance, etc...), may regain importance by managing their clients wealth or "health capital" in a coherent and personalized way, with respect to all of these specialists.

In the business sector, a company's customers, subcontractors, and suppliers should no longer have to contact different departments for each specific problem, but work with a single polyvalent mediator. These mediators will create new links within the company, considerably lightening internal coordination tasks. As a result, organization charts will be greatly simplified and management methods deeply transformed. It is well known that Japanese middle management works primarily at encouraging consensus between personnel at the base and upper management in the formulation and implementation of decisions. For many, this is the Japanese secret of success in productivity, quality and reliability. Western organizations would greatly benefit from using telema-

tics to encourage this sort of mediation.

We may also discuss the role of telephone operators. During the fifties and sixties, their main job was to set up the connection with the requested subscriber. Today, this task is almost always accomplished automatically. On the year 2000, however, the operator's mission will be more gratifying: to find, under all circumstances, someone (human or electronic machine) able to answer a question or solve a problem. The operator will also verify that the choice made is truly pertinent to the customer. Operators should also be ready to intervene, in assistance to the electronic information systems (videotex, electronic directory), to assist users who have trouble employing their own terminal. After an initial electronic consultation, the operator may refer the user to a human correspondent if he wishes to make further inquiries.

These examples lead us to believe that tomorrow essential and gratifying task for the majority of executives and employees will be "telemediation". It should open up many new jobs and stop the inflation of organizational costs. Finally, it should make telematics the key instrument for a new type of human relationship, contrary to what many fear today.

Human mediators and telemata (informational automata) must work in close cooperation. While telemata are or will be especially adept at storage, routine processing, monitoring, and surveillance, the human brain, even of average intelligence, maintains its superiority over electronic software in making choices where objectivity is limited, and in translating information to make it understandable and personalized.

This optimistic scenario evokes a sociotechnical evolution marked by the multiplication of local networks and mediators, transforming the industrial era's mass society into a new confederate decentralized society made up of semi-autonomous, convivial, but interdependent microsocieties. Yet it also represents such a revolutionary change for the major national and transnational firms, as well as for administrations and urban municipalities, that we may well wonder whether or not it is realistic.

Let us reflect, for example, on the extensive data processing systems which amass all elementary pieces of information in the decisionmaking centers for processing, then send orders towards the peripheral units for execution. This process comes dangerously close to Orwell's universe in his novel 1984. His was a world where omnipresent T.V. screens broadcast the Good Work and Good Advice of the State, or Big Brother, while sensors hidden behind the screens record all actions, speech, and even heartbeats, in order to trace any abnormal

emotions. While we haven't yet reached this stage, it must not be forgotten that many countries, even so-called "liberal" ones, exercise monopoly power over the transmission and diffusion of information, as well as radio and T.V. programs. Data files, telephone taps, invisible cameras, and bugs may also be used for various inquisitions. Filtering, normally employed to protect the individual from undesired information and to aid him in choosing that which he desires, often takes the form of imposed censoring.

Yet despite doubts aroused by such practices, we clearly see a change of course designed to extricate the economy and communication structure from the present crisis. Technical innovation alone cannot bring about the change but can strongly contribute to its success, with the aid of powerful and, at last, convergent forces which are beginning to affect the political, social, and economic spheres.

Thus decentralization, as in France, and deregulation, as in the United States, are two examples of policies aimed at redistributing, in a more equitable fashion, power and responsibility. While their methods and motivations differ significantly, they both challenge the traditional public or private monopolies in the communications area (6).

In the social and cultural domains, communication has always been a basic right which has constantly gained in richness and diversity with the appearance of new media. Freedom of opinion, freedom of speech, and, following the invention of the printing press, freedom of expression as well as freedom of the press were all won after great struggles. Today, demands for a new set of liberties are now challenging the mass media monologues (radio, T.V., advertising) and the indiscretions from private computer files. These demands concern the individual and the community at all levels: local, national, and international. They include the right to bi-directional exchanges on a democratic and reciprocal basis; the non discriminatory right to participate in public communications; the freedom to inform, and to access multiple information sources, permitting every person to select, to decide, and to deepen his culture; and the right to protect one's privacy from abusive intrusion or investigation. While these demands will one day be a part of a revised version of the Universal Declaration of Human Rights, mounting pressure is already prompting governments to satisfy them.

The essential role which communications play in the economy, whether in triggering the crisis or as a mean to end it, is still difficult to grasp; this is why I have devoted so much to the subject. The economic imperative will be the decisive factor, as it was during the industrial revolution, in imposing a new structural revolution on society. Telematic and office automation techniques

will be instrumental in providing new impetus to productivity in businesses, administrations, or public services both internally and externally, i.e., for the benefit of all customers and users. Unfortunately, just as the first generation of computers led to overcentralization, the first generation electronic office devices threatens to swell unemployment in the services sector by accelerating office work (using word processors, information bank consulting, or high speed facsimile). The second generation, however, should submit to optimal economic considerations by creating new and gratifying jobs for executives and employees in newly distributed management and organization structures. Only then will it become clear that information productivity, as a driving force in the economy, depends not on processing speed as such, but rather on the speed with which the right information is found, or the right communication set up (7). A number of experiences give us reasons for hope: speed of consensus decision-making, involving an increasing number of participants, or openness to the outside world. In one Canadian firm, for example, the number of outside communications rose in sixteen months from 20 to 50 %. Information processing now tends to take place in autonomous subsystems, which may cooperate, if necessary, offering a virtually unlimited capacity.

2.4. CONCLUSION

In 1977, Jacques de BOURBON-BUSSET of the Académie Française noted: "the new society will be made up of microsocieties or will not be at all". Although this statement could serve as my conclusion, I prefer to phrase the idea differently: the new society will be a communication society and everything must be done to make it exist very soon.

- (1) Summary of a Report, in French: J. VOGÉ, un nouvel ordre économique de l'information et de la communication, Direction Générale des Télécommunications, November, 1981.
- (2) H.A. SIMON, Proceedings of the American Philosophical Society, Vol 106, n° 6, December 1962, pp. 467-482.
- (3) I. PRIGOGINE and I. STENGERS, La Nouvelle Alliance, Gallimard, Paris 1979, Chapters V and VI.
- (4) M. EIGEN and al., Scientific American, April 1981, pp. 78-94.
- (5) Analysis and synthesis correspond to two types of thinking, rational and intuitive (or subjective), and to the action of the two (left and right) hemispheres of the brain.

- (6) It may be noted that the French decision to abandon a part of its monopoly was based on a prior reinforcement of the Administration's regulatory power, while in the U.S. it was judged that this power was far less necessary since competition was strengthened.
- (7) All periods, bottlenecks, and distortions in communications make up a significant portion of organizational costs (directly or indirectly).